OTS: 60-31,681

JPRS: 3770

29 August 1960

ANNUAL MEETING OF THE ACADEMY OF SCIENCES USSR

24-26 February 1960

Distributed by:

OFFICE OF TECHNICAL SERVICES
U. S. DEPARTMENT OF COMMERCE
WASHINGTON 25, D. C.
Price: $2.25

U. S. JOINT PUBLICATIONS RESEARCH SERVICE
205 EAST 42ND STREET, SUITE 300
NEW YORK 17, N. Y.

F O R E W O R D

This publication was prepared under contract by the UNITED STATES JOINT PUBLICATIONS RESEARCH SERVICE, a federal government organization established to service the translation and research needs of the various government departments.

JPRS: 3770

CSO: 3894-D

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ANNUAL MEETING OF THE ACADEMY OF SCIENCES USSR

(24-26 February 1960)

1. The Annual General Meeting of the Academy of Sciences USSR, which as usual, preceeded the meetings of all its departments, was convened on the evening of 24 February.

2. In the Moscow House of Scientists gathered members of the Academy, supervisors and the many scientific coworkers of its central establishments, chairmen and members of the presidiums of its branches, presidents and individual scientists of the academies of sciences and the union republics who arrived in Moscow to participate in the work of the meeting, scientific workers who head other large scientific research organisations, and also representatives of the community of the capital, of the scientific and general press and radio.

3. The Meeting proceeded under the chairmanship of President of the Academy of Sciences USSR Academician A. N. Nesmeyanov.

4. After the introductory speech of the President, Acting Chief Scientific Secretary of the Academy corresponding member of the Academy of Sciences USSR Ye. K. Fedorov presented the report on activities of the Academy for the past year.

5. Then the attention of the audience was directed to the Chief Secretary of the Chinese Academy of Sciences P'ei Li-Sheng — head of the delegation of Chinese scientists who had arrived in Moscow for the signing of the plan for scientific cooperation of the Academy of Sciences USSR and China in 1960. The scientific representative of brother China, warmly greeted by those present, gave regards to the Meeting in the name of the delegation and wished it success in its work.

6. The last part of the evening session of 24 February as well as the morning session of the next day were devoted to a discussion of the report. Twenty-five persons spoke.

7. At the evening session of 25 February participants of the Meeting listened to the speech of Doctors of Physico-Mathematical Sciences N. G. Basov and A. M. Prokhorov on the subject "Quantum Radiophysics", after which were announced the awards of Lenin prizes to workers of the Academy of Sciences USSR in the past year and awards of gold medals and imeni prizes of the Academy of Sciences for 1959. A presentation of awards was made. The gold medal imeni M. V. Lomonosov was presented to Academician P. L. Kapitsa and the

gold medal imeni S. I. Vavilov to Academician I. V. Obreimov. Corresponding diplomas were presented with the conferring of imeni prizes.

8. On the evening of 26 February the Meeting resumed its work in the building of the Presidium of the Academy of Sciences USSR. Members of the Academy elected a vice-president and members of the Presidium in connection with the termination of period of authority of the scientists who had occupied these posts, and the academician-secretaries and supervisors of the establishments of the Academy selected by the departments were approved.

INTRODUCTORY SPEECH OF THE PRESIDENT OF THE

ACADEMY OF SCIENCES USSR,

ACADEMICIAN A. N. NESMEYANOV

9. In opening the Annual Meeting of the Academy of Sciences USSR, I must, with deep sorrow, inform you first of all, that since the last Annual Meeting, the Academy has had extremely heavy losses.

10. On 27 March 1959, corresponding member Paulis Yanovich Lein'sh died; he was an outstanding specialist in the field of agricultural science. The noted geologist, Academician Stepan Il'ich Mironov passed away on 30 March. Hero of Socialist Labor Academician Gleb Maksimilianovich Krzhizhanovskiy, an outstanding scientist-engineer, an associate of Lenin, leader of the work for the creation of the first perspective plan for the development of our national economy - the GOELRO /Gosudarstvennaya komissiya po elektrifikatsii Rossii - State Commission for the Electrification of Russia/ died on 31 March. On 6 May the well known specialist in the field of Russian literature, corresponding member Aleksandr Mikhaylovich Lebedev died. The well known physiologist, Academician Konstantin Mikhaylovich Bykov passed away on 13 May. The well known scientist-historian academician Aleksandr Il'ich Tyumenev, widely known for his works on the history of the ancient East and ancient Greece, died on 1 June. The developer of the turbine drill, corresponding member Matvey Alkunovich Kapelyushnikov, died on 5 June. Corresponding member Nikolay Aleksandrovich Naumov, an outstanding specialist in the field of mycology and phytopathology, passed away on 6 July. On 17 May the famous hydrogeologist, corresponding member Grigoriy Nikolayevich Kamenskiy died. The well known scientist-historian Academician Yevgeniy Alekseyevich Kosminskiy, who headed Soviet medievalism, died on 24 July. On 9 August academician Anatoliy Vasil'yevich Venediktov, a well known scholar in the fields of civil and administrative law, died. October 17 saw the sudden death of corresponding member Nikolay Gur'yevich Chetayev, a famous mechanic and specialist in the field of the theory of the stability of motion. Aleksandr Mitrofanovich Terpigorev, an outstanding representative of Soviet mining science, passed away on 8 November. Corresponding member Aleksandr Yakovlevich Khinchin, a famous mathematician who did much for the development of the theory of probability, information theory and other theoretical and applied mathematical disciplines, died on 18 November. On 19 November, in Minsk, corresponding member Nikolay Mikhaylovich Nikol'skiy, a specialist in ancient history, ethnography and folk-lore died. On 5 January of this year, corresponding member Pavel Petrovich Parenago, a famous scientist-astronomer, passed away. Hero of Socialist Labor, the Vice President of our Academy, Academician Ivan Pavlovich Bardin,

suddenly passed away on 7 January. His life is a wonderful example of service to Soviet science which is so closely related to practice. It would be difficult to over-evaluate the significance of the activities of Ivan Pavlovich, an outstanding Soviet scientist-metallurgist, in behalf of our metallurgical industry. Our Academy owes much to Ivan Pavlovich who, for nearly 18 years did organisational work in his post as vice president. On 11 January the well known specialist in the field of psychology, corresponding member Sergey Leonidovich Rubenshteyn died. The well known astronomer, corresponding member Gavril Adrianovich Tikhov died on 25 January. On 7 February occurred the sudden death of thrice Hero of Soviet Labor, Academician Igor' Vasil'yevich Kurchatov, one of the most outstanding scientists-physicists of our time working in the field of investigation of the atomic nucleus. The outstanding organisational capabilities, the tireless energy and the inexhaustible capability for work of this man, regularly made him the leader of many of the most important works in the field of nuclear physics. His name is connected with the development of atomic technology in our country. The death of Igor' Vasil'yevich Kurchatov is an unfilable void and loss to Soviet and world science. I ask you to stand in memory of those members of the Academy who have left us.

11. During the past year, there was a successful development in the work of the Academy in the primary scientific fields. A series of interesting and scientifically and practically important results have been obtained; their analyses will be given in the report. I will only mention that three rockets, fired last year into the Cosmos, brought forth the first direct information about the state of space at distances of up to one-half million kilometers from the Earth. An astounding achievement of Soviet science and technology was the first photographs of the far side of the Moon. Fundamental data were also obtained on the location, composition, and energy spectrum of the particles of the external radiation belt of the Earth, which had only been discovered the year before. It was established that there is no magnetic field on the Moon. Here, in space research, our science firmly established itself in first place.

13. The ranges of action on matter as employed in the physical or other investigations within the institutes of the Academy are broad and continue to expand. In the expanding thermo-nuclear research - this is millions of degrees of temperature, in the successful research on synthetic crystals and allotropic transformation - this is thousands of degrees but at hundreds of thousands of atmospheres, and finally, temperatures close to absolute zero. The development of a new method of obtaining liquid helium is very important in this field.

14. The research on semiconductors is being given newer practical applications and wider perspectives.

15. An important item was the development by the Institute of Precision Mechanics and Computer Engineering, jointly with industry of the high-speed electronic computer M-20. At the present time it is being produced by industry and is the fastest of all series-manufactured machines. We are maintaining the necessary level in this important field and are moving ahead.

16. The introduction of electronic computers has its fruits in the most varied fields of science. For example, they were first utilized to analyze the working of the brain, which permitted the detection of the slightest changes in its activity.

17. I would also like to mention the very important scientific results of research conducted in the field of quantum radio physics and the development of molecular generators and amplifiers. The report from the authors of these studies will be presented to the Annual Meeting.

18. The most important results in the field of mathematics was the solution, by corresponding member of the Academy of Sciences USSR P. S. Novikov, of the "Burnside Problem" which had been unsolvable for over 50 years.

19. In chemistry, there has been a wide expansion and a rapid growth of research in the field of polymers. Many of these works have already found their way into practice.

20. We were weak in the study of natural physiologically active matter. This situation is being corrected. An Institute of the Chemistry of Natural Compounds has been established. A new Institute of Radiation and Physicochemical Biology has also started to operate. Other institutes are also doing more work in this field. We have obtained synthetic blood substitutes, anti-coagulants for the blood, anti-sclerotic and anesthetising materials, compounds with antitubercular activity, substances possessing preventive qualities against ionizing radiations. Significant successes have been achieved as well in the field of studying the structure of nucleic acids.

21. Our microbiologists have developed a method of obtaining highly active hormones - prednisone and prednisolone from cortisone and hydrocortisone. Put into practice were methods of producing bacterial ferments, valuable in an industrial sense, and a domestic hibbereline - a strongly active stimulant to plant growth.

22. Important results were attained in the field of geology and geography. Data obtained on the abolute age of the earth's crust have changed the thinking about the pre-Cambrian history of the development of the Earth. There has been a generalization of the newest geological data on the USSR and foreign countries by means of creating tectonic maps. Such factual, global material has resulted in the need for a different look at the entire geological history of our planet, and, in connection with this - the regularity of the locations of mineral deposits in it. Institutes of the Department of Technical Sciences, in addition to those works already mentioned on the study of cosmic space, conducted successful research on automation in both the theoretical and practical aspects, on radio engineering and electronics, on mining, fuels and power engineering.

23. There was a continuation of the work on the scientific basis for the unification of the power systems of the USSR into a single network. Technical-economic studies were made for unifying the systems of Siberia and the European part of the USSR which are being used in the development of a general perspective for the complete electrification of the land.

24. Technical sciences are vast. Exceptionally great is their direct influence in the national economy and there is a great number of industrial scientific institutes working in various fields of technical science. Therefore, the significance of the Department of Technical Sciences is considerably broader, as it must be, than the significance of the institutes of this Department. The Department of Technical Sciences is the most authoritative college of scientists-engineers, on whose shoulders are placed a good portion of the responsibility for the technical progress of the country. That is why the efforts of the Department should to an even greater measure be concentrated in the fields and problems of technical sciences, which are revolutionising technology - such as automation and telemechanics, radio engineering, new fields of power, etc.

25. In the field of economics, basic attention was concentrated on the economic analysis of the questions of creating a material-technical base of communism, for the location of sources and methods of increased productivity of social labor, on the development of problems of a systematic international division of labor and economic collaboration between the countries of the socialistic system of economy.

26. The economists worked well on the perspective plan of expanding the national economy of the USSR. There has been developed a standard methodology for determining the effectiveness of capital investment and new technology.

27. All that has been said demonstrates the known successes in the activities of the Academy, the increase of its scientific level, accompanied by an indubitable growth in its prestige both within the country and in foreign science.

28. The Academy also continued to grow strongly in breadth. The network of its scientific institutions, in 1959, increased by 8 new institutes, of which 5 were in the periphery, particularly and primarily in the Siberian Department.

29. In 1959, the scientific cadres alone of the Academy, including the Siberian Department, increased by 2500 people. The average tempo of increase of the Academy's scientific cadres during the past four years has been 11.6%. I will mention that in 9 years the number of scientific workers in the Academy has increased almost threefold; of this, the number of candidates science has increased 2.7 times, while the number of doctors of science - only 65% (606 individuals). For an increase of 100 scientific workers, we thus have 33 candidates of science and only 4 doctors of science. The rate of increase of highly qualified cadres - doctors - leaves much to be desired and must be increased.

30. The yearly increase in grants to the Academy (including the Siberian Department) was, on the average, 12.4% during the past 4 years. In 1959, the Academy expenditure of the state budget was 1574 million rubles, of which 197.5 million rubles was for the Siberian Department. One should mention the gradual increase in expenditures of the scientific institutions' portion of scientific-operational expenditures, which, from 31% in 1956 has grown to 35.4% in 1959, even though it is apparent that this is still not enough.

31. In 1959, 814 million rubles were spent on capital construction as opposed to 507 million rubles in 1958, including the Siberian Department - 418 million rubles as opposed to 196 million rubles. The increase of grants for capital construction has permitted a considerable increase in the availability of working space and living quarters. Put into operation in 1959 (excluding the Siberian section) were 47 thousand square meters of working space as opposed to 32 thousand square meters in 1958, and 43 thousand square meters of living space as opposed to 35 thousand square meters.

32. I wish to state, with satisfaction, that, in general, we were able to cope with the publishing affair. Printing did not turn out to be a bottle-neck in the Academy's activities and it basically meets our needs. The volume of our book and magazine production for 1959 was more than 50 thousand publishing sheets (approximately 800,000 pages), and of these the Academy Publishing

House had nearly 35 thousand sheets including over 18 thousand sheets of non-periodic publications. I will remind you that the entire press production of the Academy Publishing House for 1959 was 13,768 sheets. The Publishing House has increased its activity in Eastern literature, publishing, in 1959, 2148 sheets of books and magazines, practically twice that of 1958.

33. A significant growth of book and magazine production during the past years has, to a considerable degree, facilitated the elimination of the poor situation in the publication of the works of the Academy's scientists: more than 1000 different books were published in 1959.

34. In spite of the increased network of academic magazines which has reached 87 titles at the present time (excluding the reference works), and an increase in the number of sheets, difficulties still exist in the publication of scientific works, and a number of magazines have a backlog of manuscripts. We must remember, however, that it is not enough to merely follow the path of increasing magazine volume and coverage. The editing offices must be more selective in their selection of articles, must cut down on their volume, and should print the scientific material in a more condensed manner. The readers' interests should also be kept in mind.

35. The All-Union Institute of Scientific and Technical Information has considerably expanded its activities and in 1959 provided timely publication of 11 series (out of 13) of Referativnyy Zhurnal (Abstract Journal) in such fields of science and technology as astronomy and geodesy, mechanics, mathematics, metallurgy, physics, geology, geography, machine building, biology, electrical engineering, and chemistry. In the 202 issues of its various series published last year, more than 550 thousand abstracts were published. Referativnyy Zhurnal is now finally being published in specified periods and this, we trust, will continue on into the future. The time lapse between the appearance of the original article and the abstract exceeds 8 months only in individual cases and is being systematically decreased. We consider 5-6 months as the ideal. The Institute has embarked on a course of serious automation of its own work and the business of scientific information as a whole.

36. The many facets of the Academy's activities, however, are still not satisfactory. Even at the last Annual Meeting we stated that the main problem was that of increasing the quality of the scientific works of the academic institutes. Meanwhile, there is little doubt that in the current year our growth has passed the growth of the scientific level. Although the Academy participated in the formation of the most important contemporary scientific o

problems, its role was not always the primary one and, in a number of cases, it was not provided with the necessary concentration of forces in the development of such problems. We cannot recognize the great practical returns of the Academy's work. In the intensive production of a scientific semi-product there is an insufficient distribution of the final product. The coordinating role of the Academy, as the director of the scientific orchestra of the USSR cannot be acknowledged as satisfactory, even though this topic was the subject of anxiety and discussion by the Presidium of the Academy and our preceding Annual General Meeting.

37. In May 1959, the Academy, as was decided by the General Meeting, worked out the question of improving the coordination of scientific research in the country. In the examination of this project, mention was made of the difficulties and deficiencies in the work of the Academy which had been partially discussed at the last Annual Meeting and partially just mentioned by me. It was said, in particular, that the Academy was scattered in the direction of its work, that a number of its institutes have a purely branch function, and, being in a system and under the control of industry, could be considerably more useful. In the end result, we were committed to the preparation of concrete proposals for improving the work of the Academy, and the questions of coordination were marked for examination simultaneously with these proposals.

38. As a result of a series of discussions, a project was developed for such proposals and they were preliminarily discussed in early July. Fundamentally, these proposals, developed with a consideration of the decision made by the Academy at the General Meeting, met with approval. The formulation of the final editing of the project is being continued by those agencies which received the corresponding committments. To this still unfinished work, we brought in a large number of Academy workers and other scientists. Paralleling this, the Academy Presidium at a number of its expanded sessions discussed the designated measures and improved the project. This work should be continued.

39. I consider it necessary to set forth before the General Meeting the basic features and concepts of the project at that stage of its development which exists at present. Its basis is the concentration of the Academy efforts on a comparatively few of the major contemporary scientific problems and leading fields of science. These fields were discussed at the last Annual Meeting.

40. The project places upon the Academy, with the participation of the Gosplan, The Ministry of Higher and Secondary Special Education, and the academies of sciences of the union republics, the obligation to formulate and present to the state for approval

the basic directions of scientific research in the USSR. The annual Academy work plans, according to the project, will be authorized by its Presidium, while the basic directions of scientific research of the country, it is expected, will be approved together with the plan for national economy and as a part of it.

41. The second main function of the project is that of organizing the coordination of the most important problems of science on an all-union scale by means of creating councils on problems as organs of the scientific society, strong with high scientific authority but not possessing administrative powers.

42. A similar coordination is expected for problems of a regional nature with the participation of union republic academies of sciences. All of this also corresponds to the proposals of the last Annual Meeting. It is clear, however, that the decision of the General Meeting of the Academy was still insufficient for the coordination of scientific problems on an all-union scale.

43. The third real function of the project is that of establishing a partially fluid cadre system in the Academy: a number of places in the institutes are expected to be presented to probationer-temporary junior scientific workers selected by the Academy from among the graduates of higher institutes of learning or locally assigned for periods of up to 2 years. Of this number, at the expiration of this period, the Academy has the right to leave, as permanent employees, up to 25% of those most acceptable for scientific work. The rest are subject to assignment by the republic gosplans, if they are young specialists, or are returned to their original places.

44. The project also provides for a more flexible and more adaptable structure of the Academy's institutes towards the solution of concrete problems, which was recommended by the previous Annual Meeting.

45. In conjunction with the anticipated revamping, it is expected that some of our institutes or their elements will be transferred to the Gosplan USSR, industry, and branch academies. With this, of course, it is to be kept in mind that the transfer will be made not according to any manifestations of strength or weakness in a scientific sense, but according to criteria of development of branch thematics.

46. The comments made in the press and in oral discussions about the proposals for changing the number or names of the departments were not supported in discussions and did not enter into the project. There were also no reflections in the project of a plan for transferring a considerable portion of the lesser scientific units

of the branches connected with local scientific projects, sovnarkhozes and VUZ's (vyshaye uchebnoye zavedeniye - institute of high learning).

47. The project contains instructions directed at increasing the scientific activity of the branches, strengthening the role of the departments in the guidance of the corresponding branches by the institutes, and in intensifying assistance from the Academy of Sciences USSR to the union republic academies of sciences.

48. Also included are measures to strengthen the introduction of the results of scientific works into practice by administrative organs, the creation of experimental shops, etc.

49. Such are the basic functions of the project.

50. There is no doubt of the necessity for a further increase in local science which must be sufficiently high in level, capable of participating in the solution of major contemporary problems, but closely and concretely tied in with the interests of the major industrial cross-section of its own economic region. Apparently, the newly created or expanded academic scientific centers in local areas must be adapted in time to the major growing industrial regions, primarily in the eastern part of the country in conjunction with the Siberian Department, as well as in the Urals and the Volga area. In contrast to the branches in their classical concept, each such center, I assume, must have a few but major and important institutes of contiguous specialties so that they may constitute a single scientific organism, directly related to both the departments of the Academy and to the Sovnarkhozes. It would be expedient if the expansion and creation of such centers would take place strictly according to plan — initially as the establishment of filial departments of scientific institutes existing in Moscow, Leningrad and other cities, and then with the "cutting of the umbilical cord".

51. In the projections of the perspective plan for the development of science in the USSR, being prepared at the orders of the Gosplan of the Presidium of the Academy of Sciences USSR jointly with the union republic academies of sciences, the V.SKHNIL [Vsesoyuznaya Akademiya sel'skokhozyaystvennykh nauk im. Lenina - All Union Academy of Agricultural Sciences imeni Lenin], the Academy of Medical Sciences USSR and the Ministry of Higher and Secondary Special Education, it was this line of thought that served as our line of departure.

52. I imagine that the acceptance of the specific lengthy prospects for scientific expansion in the USSR and the reorganization of the Academy's work in the spirit of the project as outlined by

will be a fully satisfactory premise for the qualitative growth of the Academy and the upsurge in the scientific effectiveness of its work and practical results.

53. That vastly significant task of selecting the most important fields of scientific research which was begun by the Academy several years ago, apparently will now receive worthy formulation completion. The coordination of work on the most important problems of science on social principles on an all-union scale will be an important factor in the fruitfullness of scientific activity.

54. There can be hardly any doubt that when we successfully cope with this rather difficult problem, life will place before us an even greater problem — coordinating research on the scale of the entire socialist camp. The growth stages of this important activity can be seen in our agreements for collaboration with the academies of sciences of the countries of the peoples democracies, and, in a number of major joint projects they have already given large-scale results.

55. In conclusion I would like, from this rostrum and in the name of the General Meeting, to express my deep gratitude to our party and government for their untiring efforts in the expansion and blossoming of Soviet science, its productivity, its leadership.

56. We will expend all efforts, all knowledge, in order to raise the science of our country to unprecedented heights.

ON THE RESULTS OF SCIENTIFIC ACTIVITIES AND THE INTRODUCTION OF COMPLETED SCIENTIFIC WORKS OF THE ACADEMY OF SCIENCES USSR IN 1959

(Report of the Acting Chief Scientific Secretary of the Presidium of the Academy of Sciences USSR, Corresponding Member of the Academy of Sciences USSR, Yu. K. Fedorov)

57. This report year was one of the most important historical markers in the life of our country, having entered upon the period of the extensive building of communism.

58. The extra XXI Congress of the CPSU which took place at the beginning of 1959 projected a grandiose program of the building of communism in the USSR. In the decisions, which were accepted by the XXI Congress per the report of N. S. Khrushchev "On the Control Figures for the Development of the National Economy of the USSR for

1959-1965", provisions were made for a new, powerful increase in the economy of the country and in the cultural and material well-being of the Soviet people. The subsequent June and December Plenums of the Central Committee, CPSU, discussed the important questions of expanding the industrial and agricultural economies and developed concrete measures of effecting the decisions of the Congress. The results for 1959 not only showed a fulfillment but a significant surpassing of the seven-year plan's first year.

59. The period of the extensive building of communist places special problems before our science. In the near future the Soviet Union will assume first place in the world in all basic indicators -- in its technological level, in its degree of industrial development, in the well-being of its inhabitants. It follows from here that in the subsequent forward progress we will not be able, to any considerable degree, to take advantage of foreign experience, and it must be our science which will have to lay new roads for further scientific and technical progress.

60. Such a position currently exists in some fields of science and technology. It must soon be established in all fields. We know that it will be so, but it cannot occur all by itself. A similar level of expansion of Soviet science will be attained as the result of stubborn efforts on the part of the entire huge collective of Soviet scientists.

61. Our science must provide a continual supply to the currently expanding technology, industry, and agriculture. It is necessary to make rapid decisions of those problems which arise in industry, to make a wide and rapid introduction into practice of the results obtained from the study of new phenomena and relationships. A great number of such current problems must be resolved in the institutions of the Academy of Sciences USSR. Apparently, our institutes must solve the more complex problems of this order.

62. Nevertheless, the immense perspective of the further expansion of national economy requires us to make bold arrangements and decisions of the major (and difficult) problems which are the basis for the subsequent movement of science, conducting work on the borders of the known, and opening up new phenomenon. Such problems whose methods of solution have as yet not been determined, must be treated by the more qualified groups of scholars and must be an important (if not the basic) element in the activities of the academic institutes.

63. Let us remember that the XXI Congress of the CPSU found it necessary to attain, during the course of the seven-year plan, an even more rapid expansion of all branches of science, the accomplishment of important theoretical research which will facilitate further scientific-technical progress.

64. With the aim of a rapid expansion of all branches of knowledge, the control figures, approved by the Congress, anticipate the creation of the necessary conditions for the accomplishment of important theoretical research and new scientific discoveries. The state is setting large funds aside for the building of new scientific institutions and the equipping of institutes and laboratories with the most modern equipment. The material-technical supply to the Academy is growing uninterruptedly. We constantly feel that great attention, the considerable solicitude for science and Soviet scientists by the Communist Party of the Soviet Union.

65. The introductory words of the President mentioned the growth of the cadres and the expansion of the material and technical foundation of the Academy of Sciences during the past year. How did the Academy operate in 1959?

66. In examining this question, we must consider that the Academy of Sciences performs two functions. Our institutions are concerned with a certain, relatively small portion of the scientific endeavours being conducted in the Soviet Union. At the same time, the organized body of the Academy of Sciences, in one form or another, guides all of the most important scientific works in the country.

67. This second function of the Academy of Sciences is extremely responsible. Depending on how well our collective executes its guidance - in a direct or roundabout way - over scientific research, will show the effectiveness of the huge funds provided by the state for the development of science.

68. The members of the Meeting have the report on the activity of the Academy of Sciences USSR. Following is a short summary, primarily on the work which has been completed in the leading fields of science as determined at the last Annual Meeting of the Academy in March 1959.

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69. The results of the work on the problems of studying cosmic space were an important victory for Soviet science which was marked in 1959. Three flights of Soviet cosmic rockets gave scientific results of exceptional value which were recognized by the entire world. An artificial satellite of the Sun was created. The external radiation belt encircling the Earth was discovered and its extent determined; an exoionospheric current ring was discovered at a distance of several tens of thousands of kilometers from the Earth.

70. The second Soviet cosmic rocket which reached the Moon on 14 September, permitted, by direct methods, a verification of the suppositions concerning the magnetic field of the artificial Earth satellite and the execution of a number of other measurements. It was established that within the limits of accuracy of the experiment, the Moon does not possess a magnetic field and does not have radiation belts.

71. For the first time a flight around the Moon was made and photographs taken of the surface opposite the Earth were transmitted by television to the Earth. In doing so, it was necessary to provide radio communication and effect control of the scientific equipment, as well as orienting it in space at a distance of 400 thousand kilometers.

72. In 1959 the second step was taken in studying cosmic space and it brought not only important information about the space around the Earth within the lunar orbit but also provided the interesting perspective of new discoveries in the various fields of science, especially in physics and biology, in conjunction with the study of the unique physical state of matter and radiation in the inter-planetary space and the possible forms of life on the nearest heavenly bodies.

73. Soviet scientists, together with the people, are proud of the fact that this step, like the first, was made by our Homeland.

74. Recently concluded tests of new powerful rockets are permitting us to plan subsequent stages of cosmic space study. The Soviet people are indeed paving the course into the Cosmos for all of humanity.

75. This year marked vast achievements in yet another important scientific-technical direction — in atomic physics and in the peaceful use of atomic energy. Work has been completed on the world's first atomic ice-breaker the "Lenin", thereby opening new hopes for utilizing the Arctic Ocean.

76. The front of scientific research in the field of nuclear physics and atomic power has been expanded. A new Institute of Nuclear Physics in the Academy of Sciences, Uzbek SSR, has been opened; it is equipped with an atomic reactor. The atomic reactors in the Academy of Sciences, Georgian SSR, and in the Physico-technical Institute in Leningrad have been put into operation. Soviet scientists, continuing on a broad scale research in the development of controlled thermonuclear reations, have attained real scientific results.

77. The successful flights of Soviet cosmic rockets and the achievements in the field of utilisation of atomic energy are simultaneous proof of the advances made by our science in radio engineering, electrical engineering, heat engineering, and in a number of other fields of science and technology. Research on solid state physics, conducted in the Physicotechnical Institute in accordance with the problem approved by the Meeting held last year, permitted a newer understanding of the nature of the strength of many substances and the mechanism of their destruction under load.

78. Important results were obtained in the study and development of new semiconductor materials and devices. Thus, in the Institute of Semiconductors in Leningrad, where research on thermoelements has been underway for a long time, success has been achieved in the creation of converters of thermal energy into electrical energy which has very important practical significance.

79. Among the other interesting results obtained in physics, we should mention the development of a molecular oscillator with exceptional frequency stability by the Physics Institute imeni P. N. Lebedev. This may be compared to a clock which deviates by only one second in a period of several hundred years.

80. The Institute of Physical Problems imeni S. I. Vavilov has gained real results in the study of matter at low temperatures. A device has been developed for the production of liquid helium without the need of intermediate cooling stages.

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81. One of the more important subjects in the summary, as approved by the last Annual Meeting, is power engineering. The electrification of the country was viewed as one of the more important tasks of the Soviet government from the very conception of our government. Now, when the GOELRO /Gosudarstvennaya Kamissiya Po Elektrifikatsii Rossii - State Commission for the Electrification of Russia/ plan has been overfulfilled many times before, the Communist party again raises the mission of a significant outstripping of other branches of the economy by the growth of power engineering.

82. In his speech at the All-Union Conference on Power Engineering Construction in November 1959, N. S. Khrushchev indicated that the projected plan for the electrification of the country in 15-20 years and the perspective plan for the development of the national economy in the same period must become the main pillars of our program of communist construction. Of considerable importance in the expansion of electrification is the transporting of electrical energy. Our institutes have done much work in this field. In the Institute of Power Engineering imeni G. M. Krzhizhanovskiy, technical-

economical study has been completed on the unification of the power systems of Siberia and the European part of the USSR into a single power system and on the combining of thermal and hydroelectric-power stations into a single system.

83. The method of electrodynamic modeling has received further growth in our institutes, and this permitted the study and the solution of many questions on regulation, control, and protection of long-distance lines of alternating and direct current electrical transmissions and joint operation of both systems.

84. The draft projects developed by the Institute of Electromechanics on super-power turbogenerators of 750-1000 thousand kilowatts are being utilized by the "Elektrosila" factory. It should be mentioned that just one 72,000 kilowatt generator of the Dnepr GES (gidroelektricheskaya stantsiya - hydroelectric station) is equal to power to all eight generators of the pioneer of Soviet electrification — the Volkhov GES; while just one 500-700 thousand Kilowatt generator of the Krasnoyarsk GES will be equal in power to all nine generators of the Dnepr station.

85. Considerable attention was given in the report year to the expansion of the various branches of mathematics and computer engineering. Last year, our mathematicians solved a number of important theoretical problems: for example, corresponding member of the Academy of Sciences USSR P. S. Novikov obtained a complete solution of the so-called "Burnside problem". Also, the mathematicians introduced new computers. One of these is the universal electronic computer M-20. In operating speed it considerably surpasses previous series production equipment.

86. Electronic computers are now coming into use for planning calculations and for the solution of certain economic problems. The Department of Economic, Philosophical, and Legal Sciences, jointly with the Siberian Department of the Academy of Sciences USSR, made an experimental mathematical calculation on an electronic computer of the inter-branch balance of production and the distribution of products in one of the economic regions of the USSR. The Institute of Complex Transport Problems and the Computer Center solved some problems on the selection of the optimum plans for railroad and motor vehicle transportation and on regulating the flow of empty cars on rail lines. The efficient movement, conducted on the basis of such calculations, will permit the economizing of facilities measurable in tens and hundreds of millions of rubles.

87. However, the work conducted in the given field is totally insufficient. The plans for the use of computers, however, in planning the national economy and in economic research are very

large. A complete expansion of such research has an exceedingly high significance for efficient management of the national economy.

88. Fundamental attention of the researchers in the field of chemical science was concentrated on the realization of the decisions of the May 1958 Plenum of the Central Committee CPSU and the XXI Congress of the CPSU.

89. In the past year, there has been a considerable strengthening of theoretical research in the chemistry and physics of polymers — one of the most important directions in science and mentioned at our meeting last year. Interesting results were obtained in the study of new polymers. Most of these polymers had an increased material thermal stability, while others, for example, penton, are distinguished as well by high mechanical strength.

90. Of extreme interest are the catalytic systems developed by the Institute of High Molecular Compounds. Their use opens new vistas for the obtainment of such important elastomers as cis-polybutadiene and cis-polyisoprene.

91. Jointly with the industrial research institutes, preparations were made for the development of tests, and in certain cases industrial production of polypropylene, polyformaldehyde, animoenanthic acid, acetic acid, and a number of other products, methods of synthesizing which were proposed by the institutes of the Academy of Sciences USSR.

92. The institutes of Chemical Physics, Petrochemical Synthesis, Organoelemental Compounds, and Electrochemistry conducted significant work on obtaining and studying polymers with conjugate double bonds possessing new and very interesting electrophysical properties. These polymers were obtained through the use of thermal and radiation actions. Among them are substances with high thermal stability and electrical conductivity changing in relation to temperature, with a high susceptibility and abnormally high dielectric constants. Some of these polymers give appreciable values of thermoelectromotive force. In studying such systems, new phenomena were discovered: the relation of electrical conductivity to the orientation of the polymer chains and others. The discovered electrophysical properties of these polymeric materials causes some of them to resemble semiconductors, ferrites and ferroelectrics, which may be of considerable interest to practice.

93. In 1959, there was a considerable expansion in work on the chemistry of semiconductors. In the Institute of General and Inorganic Chemistry imeni N. S. Kurnakov, for example, compounds were obtained possessing extremely high photo sensitivity in the infra-red region of the spectrum.

94. It is known that considerable importance has been attached at the present time to the problem of obtaining exceptionally pure substances. In connection with this, interest is found in the development by the Institute of Geochemistry and Analytical Chemistry imeni V. I. Vernadskiy of new sensitive methods of determining impurities in semiconductor materials (germanium, silicon, etc.) with the aid of radioactive analysis, as well as by other physicochemical methods.

95. Interesting results were obtained in the field of radiation chemistry. In the Institute of Petrochemical Synthesis, for example, it was shown that with a combination of radiation and thermal action on hydrocarbons a considerable decrease in the cracking temperature and a more advantageous composition of products may be obtained. The results serve as the foundation for the development of technical specifications for the design of enlarged installations.

96. Proposals were made for two new types of organic heat conductors for nuclear power reactors. The Institute of Organo-Elemental Compounds, jointly with the Institute of Physical Chemistry, developed a radiation method for obtaining organic glass of a large thickness (up to 250 mm); this year, this method will be introduced into industry.

97. The Institute of Geochemistry and Analytical Chemistry proposed a rapid and simple extraction method for separating neptunium-239 from irradiated uranium. The Radium Institute imeni V. G. Khlopin developed new extraction and ion exchange methods of separating uranium, plutonium, and other radioactive elements.

98. Among the results obtained on the chemistry of natural and biologically active compounds, one should mention the synthesis and study of organic mutagens, cancerolytic peptides, preparations with anti-tubercular, anti-helminthic activity, and others. Preparations possessing protective activity against radiation sickness were synthesized.

99. The volume of work on the chemistry of rare elements has increased. Obtained and studied were new simple and complex compounds of a number of rare elements.

100. For one of the important problems of chemistry — the theory of chemical structure and reaction capability — there were developed in 1959 the principles of the quantitative calculation of the influence of the structure (polar factors) and qualitative calculations of the influence of conformation on the condition of the tautomeric equilibrium.

101. Considerable successes were achieved in the study of the effect of free radicals and active particles on the course of various chemical reactions and processes, in particular in the new field of radiation-chemical reactions in solid phase at low temperatures.

102. The study of metals and alloys was concentrated on the development of alloys with particular properties for the new fields of technology.

103. The Institute of Metallurgy imeni A. A. Baykov developed new high-temperature materials on the basis of niobium, as well as new high-strength titanium alloys.

104. There has been a development of the dislocation theory of the effect of a sharp loss of strength and ductility of metals when a very thin layer of liquid low-melting metals is placed upon their surfaces.

105. Considerable study was made on the problem of "Radio Electronics". The Institute of Radio Engineering and Electronics has completed work which establishes methods for designing radio relay communication lines with large intervals between the intermediate stations. Developments were made in creating waveguide lines for long-distance communications with a carrying capacity of hundreds of television and hundreds of thousands of telephone transmissions. Important results were obtained in the field of studying radio waves and the creation of low-noise communications facilities.

106. New methods were developed for generating and amplifying very high frequency oscillations. Semi conductor devices were developed for low-noise amplifiers and new types of cathodes were proposed which would permit a significant increase in the operating life of electronic equipment.

107. The Radio Engineering Institute conducted important work on the creation of electronic systems for accelerating elementary particles and for studying high frequency phenomena in plasma.

108. The basis of technical progress under contemporary conditions are, as is known, automation and telemechanics. Scientific research in this field during the report year was directed towards facilitating a gradual transfer to complex automation of production processes, to fully automatic enterprises.

109. The Institute of Automatics and Telemechanics proposed new principles of building optimal and self-adjusting controlled systems. The research made permitted the successful solution of certain actual practical problems. Thus, at one of the factories

of the Moscow Sovnarkhoz, there was introduced a self-adjusting system, developed by the Institute, for the automatic selection of the optimum position in space of parts of a complex form. The use of this system has a considerable economic effect, saving, at only one factory, approximately 200 million rubles per year.

110. Of considerable interest are pneumatic devices which execute elementary logic operations. On the basis of these devices certain standard automatic control circuits were developed in 1959.

111. At the present time theoretical foundations have been created for the wide employment of the principles of optimum control of a process under the most varied circumstances. The problem is now their practical realization.

112. Thanks to computers, important problems in mechanics, particularly in the field of the aerodynamics of supersonic velocities, were solved last year. For example, the Computer Center developed methods of calculating the streamlining of blunted bodies of rotation of constant shape and bodies whose surfaces are vaporized when they move at high speeds. The best known mechanics of the world worked for many years on this problem.

113. The Institute of Mechanics proposed a new method of calculating the non linear flutter of panels for aviation and other constructions at high and supersonic speeds with a consideration for heating; it was proven that aerodynamic damping plays a very important role in calculating the axially symmetrical flutter of a circular cylindrical body. In a strict non linear Lyapunov arrangement, the Legrange theorem on the stability of movement of a solid body having cavities with an ideal and viscous liquid was proven.

114. Important results were marked in the study of our planet, its atmosphere, oceans, and earth's crust. The basic work on the program of the International Geophysical Year was concluded in 195.

115. The oceanographic expeditions of the Academy conducted extensive study of the World Ocean. Particularly valuable studies were made in the Pacific and Indian Oceans and in the waters surrounding the Antarctic.

116. Important studies were conducted by Soviet expeditions with participation of the Academy's institutions on the Antarctic continent. In the past year, Soviet scientists-polar workers created on the Antarctic a scientific station at the Pole of Relative Inaccesibility; operations continued at the station on the Southern Magnetic Pole; a remarkable crossing was made across the Antarctic continent to the South Pole.

117. Mention should be made of the completion of collection of information by the Institute of Physics of the Earth imeni Yu. Shmidt on the seismicity of the territory of the Soviet Union; seismic maps were prepared, and the preparation of corresponding reference materials, very important for calculating building norms were carried out.

118. In the field of atmospheric study, our scientists were able to advance in the development of numerical methods of long-term and short-term weather forecasting. In the past year, materials were analyzed on the structure and regime of the upper atmospheric layers obtained through the aid of artificial earth satellites and geophysical rockets, as well as by the results of studying the spectrums of polar lights and other optical and electromagnetic phenomena in the atmosphere. The new information changes the previous conceptions of the Earth's air blanket.

119. As a result of the many expeditions and field operations conducted during the course of the IGY, much material was accumulated. An important problem for the academic institutions participating in research on the IGY program is the expeditious processing, analysis, and generalization of this material. We must keep in mind that our institutions in the geophysical, geological, and geographic fields are in turn very actively gathering material in the course of field operations, but unfortunately, are moving much slower with its analysis and processing.

120. Much work was devoted to studying the fundamental laws governing distribution of the main mineral deposits in the earth's crust. The results of these studies were used in the creation of maps of the known and probable distribution of the various groups of mineral ores in bowels of the earth's crust. The methods for solving the most important problems of geology were noted - the interrelationship of tectonics, magmatism, and ore formation.

121. Much work was done by geologists in the study of gas-bearing capacity of natural materials. For the first time, a quantitative prognosis was made of the gas reserves in the entire territory of the USSR and in separate regions.

122. A classification of ore-bearing territories was developed which is the scientific basis of prospecting and surveying operations.

123. As a result of the study of rare elements in the various genetic types of hydrothermal formations, certain geological rules for their distribution were evolved.

124. New deposits of phosphorites were discovered in the Lower Permian layers of the Southern Urals.

125. A many-year operation was concluded on the formulation of prognosis maps laying the basis for plans for the development of oil and gas mining in the Pre-Caucasian and other regions.

126. A study of thermal energy resources resulted in the location of large sites in the Soviet Union with virtually unlimited resources of heat, located at deep levels but fully accessible for use for practical purposes.

127. In the study of the natural resources of our country, an important role was played by the Council on the Study of Productive Forces. It organized expeditions of a complex nature which studied the possibilities of distributing the productive forces in the various regions of the USSR and were concerned with prospecting for new sources of raw materials and energy.

128. In 1959, the SOPS (Sovet Proizvoditel'nykh Sil Severa - Council for the Productive Forces of the North), jointly with local organizations, conducted two major regional conferences in Magadan and Kustanay, as a result of which a technical-economic evaluation was made, a summary of the resources of these regions was compiled and recommendations were developed for their complex utilization.

129. In complying with the decisions of the XXI Congress CPSU and the July Plenum of the Central Committee CPSU of 1959 on measures for expediting technical progress, the Academy's institutes did considerable work on the creation of new and intensification of existing technological processes - one of the most important problems indicated by the past Annual Meeting.

130. Thus, new methods of modeling and measuring thermoelastic stresses for calculating the strength of parts for new power engineering equipment were developed by the Institute of Machine Science. The Institute of Metallurgy imeni A. A. Baykov proposed and is conducting experimental-industrial testing of the technological processing of cast iron with high phosphorous content, thereby facilitating the complex utilization of all valuable components (iron, phosphorous, and vanadium). A technological flow sheet for the extraction of germanium and gallium from power engineering coal, which is being checked out by industry, was jointly developed with the Institute of Mineral Fuels.

131. The Institute of Mining has developed a method of calculating the rational parameters and selection of parameters of mining equipment. Some of the machine building plants, on the basis of the

Institute's studies, are designing and producing equipment and devices for automation and mechanization of mining operations.

132. The Institute of Mineral Fuels has developed the theoretical bases of the processes of enriching coal — magnetic, aerosuspension, and radiometric — which permit the complete automation of the coal enrichment. A new process of oxidation pyrolysis of natural and industrial gases to obtain unlimited hydrocarbons (ethylene, propylene, etc), which is an important raw material for the production of synthetic materials, has been turned over for industrial-experimental testing. This process differs from the previously known ones by the simplicity of technological form and high output production.

133. A number of important developments in modern science, mentioned by our last year's meeting, refer to the field of biology.

134. The Institutes of the Department of Biological Sciences conducted considerable work on the revamping of the plan of scientific research in accordance with the decisions of the December Plenum of the Central Committee CPSU of 1958 and XXI Congress CPSU.

135. The critical comments directed at us at the December Plenum were assisted by a unification of the creative forces of Soviet biologists, and the rebuilding carried on in 1959 aided both the establishment of important theoretical problems and the strengthening of the bonds of the academic institutions of the biological field with the practice of agriculture and medicine.

136. On the basis of previously accumulated data, a proposal was presented to the Council of Ministers USSR and the Central Committee CPSU for the best use of natural resources, on the use of new technological processes and preparations in industry etc. Many of these have been accepted.

137. Of importance to agriculture are the proposals on combating soil erosion, on mastering and improving saliniferous lands. The putting into practice, on a large scale, of the recommended complex of measures on combating erosion (the use of anti-erosive agrotechnology, the development of protective forest growth, the sowing of grass) would permit an increase in the total grain harvest of approximately 1-2 billion poods /1 pood = 36 pounds/ annually.

138. The system of measures for improving saliniferous lands successfully passed its tests in the southern Ukraine, in the Volga area, and in Kazakhstan. This opened the possibility for a further mastery of saliniferous lands for the sowing of grain cultures and

fodder pastures. We must consider that country's land fund consists of more than 100 million hectares of saliniferous soil.

139. The results of the work of the Institute of Genetics on increasing the percent of fat in milk from cattle by means of breeding high-yield lean-milk cows with bulls of the rich-milk breed deserves serious attention. For a wide scientific-productive verification of the pedigreed properties of the selected hybrids, the Institute sent 90 bulls to the farms of the scientific-research institutions, kolkhozes and sovkhozes in various regions.

140. Important results were achieved by the Main Botanical Garden in the development of newer more productive varities of wheat on the basis of the principle of remote hybridization.

141. The Institute of Biological Physics sampled, on a semi-productive scale, and proposes the introduction in agricultural practice of pre-sowing exposure of vegetable seeds which increases the harvest by 15-20%.

142. It was indicated in the decisions of the XXI Congress CPSU that the expansion of biology will facilitate the use of its achievements attained in the fields of physical and chemical sciences.

143. In 1959, the biological institutions made a considerably wider use in their work of the new methods of physics and chemistry. Equipment was built to calculate the exact physical characteristics of biological processes.

144. The use of electronic calculators by the Institute of Higher Nervous Activity permitted the detection of the slightest changes in the activity of the brain.

145. In the Institute of Physiology imeni I. P. Pavlov, new electrophysiological data were obtained which characterize the representation of the internal organs in the cortex of the brain and prove the correctness of I. P. Pavlov's conception of the nucleus of the analyzer and its localization.

146. All this, of course, is merely the first stage in the employment of the newest experimental possibilities in the study of biological processes.

147. The study of the physicochemical relationships, lying at the basis of the manifestation of the life activity of organisms, has been considerably expanded.

148. Great successes were achieved in the study of nucleinic acids. Thus, the Institute of Biochemistry imeni A. N. Bakh discovered the phenomenon of the intermittent transition of the convoluted configuration of a viral ribonucleinic acid into an unfolded chain upon heating of the solution. It was established that the entire molecule of the natural viral ribonucleinic acid is formed by one high-polymer continuous polyribonucleotide chain with a molecular weight of 2 million. The completeness of this chain (i.e., the primary structure) plays the decisive role in the manifestation of biological activity of nucleinic acids.

149. The Institute of Microbiology has discovered the luminescence of nucleinic acids and their derivatives in the ultraviolet range under the influence of exposure to light; this has a real significance for the understanding of the changes of nucleinic acids under the influence of light radiation.

150. The Institute of Plant Physiology imeni I. A. Timiryazev has obtained interesting data concerning the energy exchange in plant roots upon absorption of nutritive elements from the soil. It was discovered that the initial assimilation of phosphate by the roots is made by means of absorption through the glycolysis and the cycle of carbonic acids into the composition of the adenosintriphosphoric acid.

151. If we are to speak about some of the contributions to medicine, then we should mention that in the report year, the Academy has begun a complex study on the problem of cancer. In addition to the Institute of Radiation and Physicochemical Biology, studies in this field were begun by the Institutes of Cytology and Biological Physics.

152. A method has been developed for transforming cortisone and hydrocortisone into new, more active, steroid hormones - prednisone and prednisolone. It was suggested jointly with the Kurgansk Medical Preparations Plant to regulate the factory production of domestic hibberillin and test samples have already been received.

153. The Institute of Microbiology has developed and turned over to design organizations, documentation for designing a factory to produce the bacterial enzyme amylase, which is of considerable importance to the textile industry.

154. Valuable results were obtained by zoologists, botanists, and parasitologists.

155. We can thus mention, that the institutes of the Department of Biological Sciences, to a considerable degree, have revised and

developed their research in light of the critical comments which were made to our biologists by the Central Committee of the Communist Party.

156. The fundamental works of the institutes of the Department of Economic, Philosophical, and Legal Sciences were concentrated on the complex study of the laws of transition from socialism to communism.

157. The institutes of this Department, together with the participation of scholars from other institutes made reports to the Gosplan USSR on the tempos and proportions of national economic expansion in a general perspective, on the complex development of all forms of transport, about the economic competition between the two systems and the projections for the economic expansion of the main capitalistic countries and others.

158. The Institute of Economics has made a theoretical development of the basic methodological questions on the balance of national economy, gave an evaluation of the conditions which determine the expansion rate of socialist economy, prepared suggestions towards increasing productivity of labor in individual branches of industry of the USSR, made studies on the basic directions for decreasing the capital capacity of social production. The basic laws and characteristics for the establishment of industrialization in individual countries under conditions of economic collaboration and international division of labor in the socialist camp were studied jointly with the economists of the countries of the peoples' democracies.

159. The Institute of Philosophy has prepared a book, "On the Emergence and Evolution of Socialist Society", which presents a systematic delineation of the basic laws of the emergence and evolution of the socialist society, and generalizes the experience of socialist construction in the USSR.

160. Considerable attention during the report year was devoted to the creation of papers generalizing the laws of historical evolution, as well as the preparation of lesson books and study materials. We should mention the multi-volume "History of the USSR" (from the ancient times to the present day); five volumes of this publication, which it is hoped will be completed by the 50th October Anniversary, are devoted to the history of Soviet society. The compilation of a five-volume general study, "The History of the Great October Socialist Revolution", has commenced.

161. We should mention that volume VI of the multi-volume "All World History" has been published; a number of institutes of the

Department of Historical Sciences participated in its compilation; the work on volumes VII and VIII has been completed.

162. The Institute of Philosophy has published volumes III and IV of the "History of Philosophy" which reveal the most important stages in the development of philosophy in various countries and on the philosophy of the peoples of the USSR up to the beginning of the epoch of imperialism and the proletarian revolutions; particular attention is devoted to the questions on the formation of Marxist ideology.

163. An additional publication of the collective works "The Fundamentals of Marxist Philosophy" was prepared in which a systematic exposition is given of the bases of dialectic and historical materialism, generalizations are made on the practice of communist construction and the newest information on modern natural sciences, criticisms are made of the main trends of modern bourgeois philosophy and sociology.

164. The growth of Soviet literature is characterized by the urge to solve actual problems of modern literary life and a deeper, in comparison to previous years, attention to the theoretical problems (socialistic realism and the courses of its evolution, general laws of the literary process in individual national literatures, etc.). The development of the theory of Marxist literary writing is organically tied in with the struggle against foreign bourgeois and revisionist concepts, especially against structuralism which has recently become active.

165. Measures were taken in the field of linguistics to strengthen the scientific research work on the theory of Soviet language science.

166. A considerable and still increasing portion of scientific research is being conducted in institutes and laboratories, which are under the jurisdiction of the branches of the Academy of Sciences USSR. During 1959, the position of the branches became a little stronger. Their scientific production was also increased.

167. It is impossible to enumerate all of the works conducted by the branches, therefore, we must limit ourselves only to individual examples to characterize their activity.

168. Thus, the Ural branch developed the theory of a new geophysical method - a continuous active core sampling by electrical means for the location of ore zones in bore cross sections. New results, obtained in the field of the chemistry of dispersed and rare elements (gallium, germanium, selenium, etc.), permitted a

recommendation of the technological methods for the recovery of a number of these elements and have been accepted by industry for use.

169. A technological scheme was proposed for obtaining ferro- and manganese-silicon from the poor phosphorus ores of the Urals which will permit us to eliminate the transport of manganese alloys from the southern areas of the country to the Urals.

170. A large number of organophosphorous compounds, actively effective against the most varied blights of agricultural and fruit cultures were synthesised in the Chemical Institute of the Kazan branch. Preparations for the treatment of eye diseases, glaucoma, herpes tonsurans and others were developed and introduced into use.

171. The Kol'sk branch, for the first time in the USSR, developed a flotation method for ferrous quartzite, thus producing iron ore concentrates with a high iron content. The method is being introduced into practice at the Olenegorsk mining-processing enterprise and the Cherepovetsk metallurgical plant and will permit a saving of up to 70 million rubles annually.

172. The Moldavian branch has completed its work on the introduction of European grape cultures, one of the most stable against phylloxera. The savings which this work will provide during the seven year plan in Moldavia alone will be measurable in the hundreds of millions of rubles.

173. The Dagestan branch has completed an interesting work based on the construction, close to the Makhachkala thermoelectric station, of buildings using terrestrial heat. Research on the thermal conductivity of indium antimonide in a magnetic field has permitted a verification of the existing theory of the Madzhi-Riga-Leduk effect for the case of strong magnetic fields. The correctness of the theory of this effect was verified.

174. We must mention, in addition, that the supervision of the scientific enterprises of the branches by the departments of our Academy still remains, as before, insufficient.

175. The Siberian Department holds a particular place within the territorial organization of our Academy.

176. All of us understand the huge role of the natural resources of Siberia in the future increase in the productive forces of the country. We greeted the patriotic beginning of many of our outstanding scholars and youth who took part in the rapid expansion of science in the more important centers of Siberia.

177. The body of the Department totals, at the present, some 2000 scientists and 3000 scientific-technical workers. In 1959 nearly 600 scientific research projects were completed, and the results of the work on 25 of them have already been introduced into practice.

178. The first production of the newly created institutes of the Siberian Department came out in the report year. These completed works deal with various fields of science.

179. The Institute of Hydrodynamics, for example, conducted theoretical research on the jet flow of gas, developed a theory of wave motion of liquids in shallow waters (in connection with the problem of "tsunami"), showed the action of cumulative charges in ground cracking, etc. The Institute of Theoretical and Applied Mechanics and the Institute of Chemical Kinetics and Combustion studied the questions concerned with power steam-gas equipment. The Institute of Mining has published a monograph on the development of the coal deposits in the Kuzbass. The geologists of the Siberian Department conducted considerable research.

180. The Institute of Experimental Biology and Medecine improved methods of studying the human circulatory system and methods of surgical operation on the heart and vessels, thus permitting the introduction of surgical operations of the heart into practice at the Novosibirsk hospitals.

181. We wish to give our best wishes to the pioneers of the Siberian Department, and to all of their compatriots, for further successes in their work: academicians M. A. Lavrent'yev, S. A. Khristianovich, S. L. Sobolev, A. A. Trofimuk, P. Ya. Kochina, Yu. N. Rabotnov, corresponding members of the Academy of Sciences USSR A. V. Nikolayev, K. B. Karandeyev, N. N. Vorozhtsov, E. E. Fotiadi, and G. K. Boreskov.

182. This past year was marked with brilliant successes in the foreign relations of the Soviet Union. The visit of the head of the Soviet government, N. S. Khrushchev to the United States was a turning point in international relations. The persistent struggle of our government for the prevention of a threat of a new war, for a softening and a normalization of international relations, is supported by the majority of the people of the world and creates favorable conditions for the development of international cooperation in the realm of science.

183. All of this found its reflection in the development of the international ties of the Academy of Sciences. Nearly 800 Soviet scholars travelled to the capitalist countries and approximately

the same number to the socialist countries. More than 1500 foreign scholars from the capitalist and socialist countries were received by the Soviet Union.

184. Our foreign ties assisted in the strengthening of the priority of Soviet science and in our employment of the experience and knowledge of foreign scientists. Thus, the Institute of Silicate Chemistry used the experience of the Chinese specialists in the field of enameling; the suggestions of the Institute were considered in the industrial production of thin-walled enamels for dishes. Scientists of the Department of Biological Sciences mastered the method of electrophysiological study of the nervous system developed in Hungary, the methods of studying metabolism in plant roots through the use of radioactive isotopes as practiced in the GDR.

185. At the Conference on the Physics of High Energy Particles, familiarization with American work on the determination of the internal parity of π-mesons resulted in the elimination of analogous work from the plan of the Physics Institute, thereby permitting a saving of a great amount of time and effort. Materials of the Conference on Molecular Spectroscopy, conducted in Italy, permitted recommendations to be made on the organization of series output of improved spectrometers.

186. It must still be stated, that we are making poor use of the information obtained as the result of the many foreign visits made by our scientists. It is necessary to make a marked improvement in the information in this field so that all interesting foreign achievements may be rapidly utilized by our institutes.

187. The institutions of the Academy of Sciences USSR, during the past year, continued to provide freiendly assistance to the academies of sciences of the socialistic countries by means of sending qualified specialists, forwarding of various materials and training of personnel. Nearly 500 young scientists from the socialist countries have undergone apprenticeship and aspirant training with us.

188. Scientific ties were also broadened with the capitalistic countries. In addition to the earlier made agreement on scientific cooperation with England and France, the Academy made agreements with the scientific institutions of the USA, Canada, and West Germany, in 1959.

189. Of considerable importance is our participation in international scientific organizations. At the present time we belong to 82 organizations. Nearly 400 Soviet scholars are members of

various committees, commissions, and other agencies of international scientific councils, associations, and federations. In some of them, Soviet scientists hold leading positions; for example, academicians L. I. Sedov, A. A. Blagonravov, corresponding member of the Academy of Sciences USSR V. V. Belousov, Doctor of Physicomathematical Sciences A. M. Letov, and others.

190. The Academy participated in the very important measures promulgated by international scientific societies. These include: the International Oceanographic Congress in New York, The XVII International Congress on Theoretical and Applied Chemistry and the International Symposium on High Molecular Compounds in West Germany, the International Congress of Physiologists in Argentina, the International Congress of Sociologists in Italy, etc.

191. Some similar meetings were conducted in the Soviet Union. The active participation of Soviet scientists at international congresses, conferences, symposiums, testify to our great contributions to world science and to the wide recognition of the successes of Soviet science by all countries of the world. This is a beneficial and necessary activity. Nevertheless, the Presidium of the Academy of Sciences, the councils and national committees representing the USSR in the international scientific unions, should examine more attentively the present forms of international scientific cooperation, which, in many instances, are far from perfect, and take steps to see that they answer the modern position of science and the requirements of efficient organization.

192. The General Meeting of the Academy which was held last year underlined the need to strengthen ideological work among the scientific workers of the Academy's institutions and paid particular attention to the need of developing the activities of methodological seminars on the philosophical generealizations of contemporary achievements of science. The Presidium of the Academy accepted the decision for a subsequent improvement in the activity of the philosophical (methodological) seminars, on work in the enterprises and on scientific propaganda. It should be stated that work in these fields revived in 1959.

193. The philosophical seminars, which, according to the Presidium's decision, were included in the general system of scientific activity of the institutes, began to function more satisfactorily. However, the authorities in some of the scientific institutions did not understand the importance of the measures set forth by the Presidium. In a number of institutes, for example, in the Soil, Plant Physiology, Minerology, Geochemistry and Crystallochemistry of Rare Elements, and others, not one philosophical seminar has as yet been held.

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194. Such are the brief characteristics of the results of work in the most important fields as determined by the previous Annual Meeting, with certain comments on the activities of the branches and on international ties. It must be assumed that there will be included in this summary, additions and corrections by the participants of this meeting in their reports.

195. The total scientific activity of the Academy is truly great. However, they could have been better if it were not for the deficiencies which exist in our work.

196. As already mentioned by the President in his introductory remarks, the growth of our scientific institutions is broadly surpassing the tempo of construction and equipping of institutes and laboratories. In connection with this, there arise difficulties in providing work on proper facilities and there is evidence of a lack of certain types of equipment, etc. These difficulties will be overcome; the gap between the requirements of the institutes and the possibilities of complying with them is being systematically reduced.

197. Many of the shortcomings are related to an insufficient control of the work of the institutes and laboratories on the part of the Departments and the Presidium, with a formal character of this up to the evidence of the most common burcaucratism, a slow processing of documents, the lack of personal supervision, etc. Such shortcomings still exist in great numbers. They are not, however, the main hinderance to the growth of scientific research in the country. Apparently, the basic shortcomings to which we must devote the most serious attention are that we have not yet learned to correctly organize and coordinate scientific research, we have not mastered research by projected planning.

198. An important place in the organization of scientific research is filled by the concentration of resources and facilities in the basic directions of scientific research, and, first of all, by the determination of these self-same basic directions.

199. In the past year, the Presidium of the Academy and all of the academy's institutions devoted considerable attention to the questions of the organization of scientific tasks, and some work was done in this field. Thus, the Presidium and the Departments of the Academy clarified the plans of scientific research in accordance with those basic directions which were established by the previous Annual Meeting. In conjunction with this, there was an expansion in the study of those problems seen as most pressing, for example, on polymers in the chemical institutions, on the location of useful

minerals in the geological-geographic, etc. Some less important topics were eliminated from the plans of the institutes.

200. It must be said, however, that in this field, only the very first, and actually preliminary, step have been taken. Substantive changes which must take place, especially along the line of eliminating unrealistic and purely branch topics, have still not been effected.

201. The coordination of work on problems is being conducted by a large number of various councils, commissions, or committees. Some of these exist within the Presidium of the Academy. In general, these councils and commissions, have somewhat improved their activity during the past year, while some of them are operating successfully. For example, in the Department of chemical sciences, the Council on the Problem of the use of Atomic Energy in Chemistry systematically conducted sessions of commissions and the results and plans of research were discussed. The Council on the Problem of the "Theory of Chemical Structure, Kinetics, and Reaction Capabilities" operated successfully.

202. In the Department of Technical Sciences, we must make mention of the Council on the Problem of Strength and Plasticity. It not only meets on a monthly basis, but has also prepared for publication a bulletin about the course of its work.

203. The Council on the Problem "A History of the Great October Socialist Revolution" is actively at work.

204. However, the majority of the existing councils and other coordinating agencies do not satisfy the requirements set forth before them. Many of the councils are nothing more than organs of the institutes and are composed of institute workers which, of course, narrows their coordinating function.

205. The majority of the scientific councils did not apply information on the work on the problems. Liaison is poorly established with the non-academic institutions, the VUZes and branches of the institutes. The directives of the Presidium concerning the discussions on combined plans on 1960 problems have not been adhered to; attention is not being devoted to an examination of results of work; recommendations are not forthcoming about the introduction of one positive result or another.

206. In this manner, the activity of the existing councils has serious defects, and the coordination of scientific research is moving quite poorly thus far.

207. There has been an improvement in the work of the Presidium and the bureaus of the Departments, although, obviously, the participants at this meeting can better speak about this.

208. Thus, in spite of the great successes of Soviet science of which all of our people are proud, we must remember that our activities still do not satisfy, to the required degree, the requirements of the country, the requirements of practical work; at the same time, we are expending very much effort and facilities on secondary and unrealistic research.

209. We have become accustomed to comparing the condition and achievements of our work with the foreign level. This, of course, is a healthy comparison and it will remain a healthy comparison for a long time to come. We still have much to do in order to take over first place in the solution of all scientific problems. But this is not the limit. We remember the words of N. S. Khrushchev to the effect that our country will, in the near future, overtake the leading capitalist power—the United States of America—and will go forward, leaving it behind us. And this means that the basic criterion for an evaluation of the status of our affairs is not the foreign level, but is the <u>conformity</u> to the completed and proposed needs of our national economy.

210. We are now developing the plans for the growth of our country for the next 15-20 years. Our scholars are participating in this work and are assisting the governmental agencies. They are assisting, in particular, in considering for the plan that which has already been achieved by science. But it is also necessary to foresee future scientific achievements. To do this, it is necessary to know how to properly evaluate the development of science, to plan, or better yet, to foresee the discoveries and to calculate the periods of time for their introduction into practice. The greater our success in doing so, the better we will be able to utilize our time - a factor of the most important significance in our peaceful competition with capitalism.

211. In the forthcoming years, new institutes and laboratories will be organized, accelerators, telescopes, ships and various other facilities will be developed for scientific research, tens of thousands of new scientific workers will be trained. However, in order for the great army of Soviet scientists to work effectively and rapidly, we must have clear coordination and a correct evaluation of the perspectives of scientific research. First of all, this is necessary for the Academy collective, for its institutions.

212. Under the leadership of the Communist party, our people have overcome an age-old backwardness, have broken the resistance

of a multitude of enemies and has now entered on the decisive stage of peaceful competition with capitalism.

213. Together with us are our brother socialist nations. On our side is the sympathy of millions of progressive people of all countries. Can there be any greater joy for a scientist than that of belonging to the Soviet people, to work on giving life to the leading ideas of humanity.

214. Soviet scientists are proud of that attention and trust which the Homeland bestows upon them. They will devote all of their efforts and knowledge towards the fulfillment of the grandiose missions which the Soviet government, the Communist Party of the Soviet Union has placed before science.

DISCUSSION OF THE REPORT

Academician I. I. Artobolevskiy

215. The Regulations of the Academy of Sciences USSR contains the point that the Academy assists in popularizing scientific achievements. Very many of the institutes, primarily of the humanitarian type, and individual scientific societies which are in the Academy do considerable work on the dissemination of scientific knowledge. But, unfortunately, not all of them. For example, in the Power Engineering Institute, a group of members of the All-Union Society for the Dissemination of Political and Scientific Knowledge consists of 9 people. In other institutes, such groups have still fewer members.

216. Many of our outstanding scholars - academicians, corresponding members and doctors of science - avidly come forth with lectures and reports and are active propagandists of scientific knowledge. But the basic mass of our co-workers still do not sufficiently participate in this work. It is necessary that the representatives of our natural sciences — physics, chemistry, biology, engineering — assume their rightful place, particularly since there is considerable interest in the achievements in this field.

217. Another course of disseminating scientific knowledge is through the publication of popular books. I must say, that books being published in our scientific-popular series are always written by outstanding specialists, on a high scientific plane, but, unfortunately, the greater majority of them do not have the character of popular publications, but rather of short monographs designed for the well trained reader.

218. Such popularizers of science as V. A. Obruchev, V. I. Vernadskiy, S. I. Vavilov, A. Ye. Fersman, knew how to bring in a remarkable form the most difficult scientific questions to the broad mass of readers. The editorial offices which are concerned with the publication of popular books should consider that there must be books of various scientific levels designed for different types of readers.

219. Recently, when serving as a jury member for international awards for scientific-popular books, I read approximately 40 popular books published abroad. Among them I discovered the most wonderful forms of popularization. The most difficult questions of astronomy, biology, theory of relativity, cybernetics, were explained in an extremely colorful and presentable form. Perhaps we should consider the translation of some of the popular books which have been published abroad.

220. In conclusion I would like to express the hope that in the next report on the Academy's activities, all of our institutions will be worthily presented as propagandists of scientific knowledge.

Corresponding Member AS USSR L. A. Zenkevich

221. Now, the thoughts of the researcher, the engineer's thinking, concretely, in a realistic form, are approaching the problem of drilling into the earth's crust below the ocean, through the entire thickness of the bottom sediments and through the entire earth's crust to the mantle. If we can imagine what this work will give us, then the use of the term "colossal" is not an exaggeration.

222. It must be said that a rapid solution of many problems of geology, geophysics, climatology, is impossible at the present time in view of the lack of corresponding methods. A seismographic analysis of all that lies under the ocean's bottom does not give reliable results with sufficient accuracy. However, drilling through the earth's crust with all of the bottom sediments will permit, in a rather short time, the solution of a number of questions on the history of the ocean itself, its level, salinity, and the life that was in it.

223. A number of other problems arise, for example, the paleontological, inasmuch as the two kilometer thickness of ocean sediments contain, in one form or another, not only the history of the earth's climate, but also, to a significant degree, the history of cosmic space.

224. The study of the ocean bottom has a very practical importance as it contains untold mineral wealth. It has been

established that there are easily obtainable reserves of iron-manganese concretions totaling some 8 billion tons lying along the surface of the Pacific Ocean's bottom. This remarkable ore contains copper, cobalt, nickel, and others. The bottom deposits probably contain other wealthy mineral resources, and they undoubtedly also exist in the crust along the Mohorovicic line.

225. In the fall of last year, the Presidium of the Academy of Sciences USSR, giving considerable significance to the growing role of the oceans and seas to human life, decreed the inclusion of the study of the nature and resources of the oceans into the leading scientific problems. However, the development of this problem, despite its extreme scientific and practical significance, has not been aided by our Academy. It is necessary, in the very near future, to take the most decisive steps for the correction of this situation.

Corresponding Member AS USSR, V. V. Belousov

226. The International Geophysical Year (IGY), which had been extended for an additional calendar year, came to a close on 31 December 1959. This grandiose scientific action, in which scientists from 66 countries participated, went through with very great success.

227. Important scientific results were achieved, principally, in all fields of geophysics. Now, the most important stage has arrived and the success of the entire work depends upon it. This stage is the equipping of the World Center, which is situated in the USSR, with all of the materials of the IGY, and the processing and scientific utilization of all of the obtained results.

228. Meanwhile, some of the Academy's institutes which are responsible for the scientific mastery of the results of observations, are not showing the desired activity and we risk losing that competition which has now developed between the IGY participating countries in the practical employment of these results. The leaders of the scientific institutions of the Academy must keep these works in the center of their attention.

229. At the same time, it is necessary to strengthen for the future the high level attained in the carrying out of geophysical research. At the present time, geophysics is a means of the scientific mastery of our planet. A very dangerous near-sightedness is being demonstrated by those scientific leaders who feel that following the IGY, the level of observations may be lowered considerably. Some sensible changes in the program are possible, of course, but the front of geophysical research must, without any doubt, be expanded.

230. The point is that the program of the IGY was directed up rather than down: the problem of Sun - Earth, the processes in the ionosphere, meteorology, these then are the problems which were found in the center of this program. And relatively little was done for the study of the solid interior of the Earth as a source of mineral resources and energy. What we know about the composition and structure of the Earth's interior and of the processes which occur there is laughably little. This is the direction in which we have to concentrate greater efforts. Our Earth will remain for a long time the same base on which man lives and will live.

231. I feel that the Academy of Sciences USSR will display the proper perspective feeling if special attention will be given to the many-sided development of the physics of the Earth's interior.

Academician A. L. Mints

232. The expansion of radioelectronics, semiconductors, and ferrites has already begun. Now comes the study of high frequency phenomena in plasma which presents considerable interest for controlled thermonuclear synthesis, for new systems of accelerating elementary particles and, finally, for generating and amplifying super-high frequency oscillations.

233. We must master plasma in the same manner as we are mastering conductors and dielectrics - this is one of the leading perspective problems of modern radio electronics.

234. Further, I will touch upon the inter-relationship between academic institutes and institutes and industrial plants, and the introduction of the results of scientific efforts. It seems hopeless to me to try and find a line of demarcation separating academic scientific activity and the work of the branch scientific-technical institutes. Science is one, and the problem is the attainment of the smoothest possible transition from one form of scientific activity to another.

235. Many scientific tasks, by virtue of specific reasons, should be conducted only under factory conditions. Their main aim is the improvement of technology. When their results are introduced, technical risk, as a rule, must be excluded.

236. The basic goal of research conducted by large branch institutes and design bureaus is that of developing new designs for machines, devices, installations, the search for principally new technology for production processes. In the solution of such problems,

technical risk is fully legitimate. The participation of these institutes in the work of the factories, right up to the mastery of new production, is mandatory.

237. The institutes of the Academy of Sciences must develop the basic directions of scientific research, must conduct questing operations which are coupled with considerable risk. However, the plan must be so designed that a large portion of the research would lead to successful results. Research work must be delegated to the more talented and unselfish scientists.

238. Clearly, neither the subject nor the branch of science serves as the criteria for the division of the institutes into various categories. The main criteria are the degree of permissable risk and the rigidity of the plan of developments.

239. We should not unify the form of introduction nor the work methods of the individual institutes. If there is the possibility of realizing in the academic institute the entire chain of development, then we should not fear this. It is also fully proper to have collaboration between the academic institute and the branch or the factory even in the early stages of development. But at all stages, the workers of the academic institute must be concerned with their own pet projects.

240. Valuable and sufficiently completed scientific works will always find their way into life and will facilitate the solution of important problems which face our country.

Academician V. V. Shuleykin

241. Permit me to add certain data concerning the physics of the oceans to the report.

242. As it is known, all that occurs in the ocean depends, first of all, upon the solar heat which falls upon its surface. Even at the time of Second Geophysical Year, which was called the Polar Year and took place during 1932-1933, our country, for the first time in the world, invented and employed a special ship-board solar energy receiver on expeditions. Since that time, this work has received broad development, and during the IGY, through the use on Soviet vessels of new modern equipment developed primarily by the Marine Hydrophysics Institute of the Academy of Sciences USSR, a number of important studies were conducted. The most interesting, and I would say, fundamental, is the work of one of the members of the Marine Hydrophysics Institute, Yu. G. Ryzhkov, who, while on board the "Ob",

recorded the sum total of solar heat beginning at 64° south latitude to 60° north latitude. No one in the world has yet done this on such a scale.

243. Research was conducted on the precipitant growth of telluric currents in the depths of the ocean waters, which was discovered by the same Yu. G. Ryzhkov in The Indian Ocean in 1956. The build-up occurs according to a linear law, and it can be assumed that these currents, to a considerable degree, are responsible for magnetic declination; this presents enormous practical interest both to mariners and to geodesists. Their first recording in deep waters was made by us from the ship "Sedov" in 1957. It confirmed the discovery of Yu. G. Ryzhkov. It was possible to record the deep rapid build-up of currents, and subsequently, in 1959, to measure the magnetic declination at great depths. This work established that one third of the magnetic declination, especially in the Atlantic, are related to currents of the World Ocean.

244. There is much more for science to do in the field of studying the origin of atmospheric electricity and earth magnetism. Valuable work in these directions was conducted aboard the non-magnetic schooner "Zarya".

245. Finally, it seems to me, that mention should be made in the report of those problems which were solved on our new first-class-equipped expeditionary vessel "Mikhail Lomonosov". Last year, the workers of the Marine Hydrophysics Institute conducted broad work in such a field of geophysics as optics of the sea, which also had its conception in the Soviet Union. Some of this research was conducted on the "Mikhail Lomonosov".

Academician A. Ye. Arbuzov

246. I will pause on several questions.

247. The first of these is the organization of scientific research.

248. That science must be planned and that scientific research must be coordinated is plain to each of us. This question has a side, however, which is not so clear; it is the parallelism of scientific research. I make a differentiation in the development of science between useful parallelism and harmful parallelism. The classical example of useful parallelism is the simultaneous development of the problems of the synthesis of caoutchoue conducted by three of the leading scientists of our country — S. V. Lebedev, B. V. Byzov, and I. I. Ostromyslenskiy. That problem, as we know, was

most successfully solved by S. V. Lebedev. Such parallelism, I imagine, must have a place in the development of problems, whose solutions, according the statement of our President, will herald the entry to the next floor of the building of science, as well as the most important problems decreed by national economy. Consequently, the problem of planning and coordinating science must lead to the struggle against useless and harmful parallelism.

249. I would also like to pause on an extremely important question, that of the introduction into the national economy of the results of scientific research. Unfortunately, the report hardly mentions this. Meanwhile, the situation on introduction is far from satisfactory. For example, our Kazan laboratories have synthesized a large number of organophosphorous compounds which actively work against the most varied blights of agricultural and fruit cultures. Many preparations have passed all established tests and received the highest evaluation. However, their introduction into practical use was delayed for several years. True, I just recently received information that this year, finally, there will be produced 200 tons of our preparation "oktametil" and 150 tons of "ditiofos". Thus, a start has been made. But it is only the beginning.

250. In a somewhat better condition is the introduction into practical use of our organophosphorous medical preparations. The greatest success has been with "fosarbin" which is used for the treatment of glaucoma. A great demand is rising for these preparations, however their industrial production had not been carried out for several years. Organized only recently was the procurement of fosarbin in the required quantities organized (at the Kazan Pharmaceutical Factory).

251. The questions of introduction into practice have a great state significance and therefore deserve the most fixed attention.

Academician V. A. Engel'gardt

252. I would like to mention with satisfaction that, in the reported material on the activity of the Academy, considerably more space is given, than in previous years, to those tasks which reflect the line of expansion of biological research tied in with the participation and permeation of the proximate sciences — chemistry, physics, etc. This line fully answers those problems which were placed before biological science by the XXI Party Congress.

253. Until recently, there existed with us, unfortunately, some kind of a very rigid and unsurmountable barrier between the institutions and activities of the Departments of Biological

Sciences on one side, and of Chemical and Physicomathematical Sciences on the other. We can now, however, mention such real steps as the establishment, last year, of an Institute of Radiation and Physicochemical Biology, the appearance of new cells with biological problems in the institutions of the Departments of Chemical and Physicomathematical Sciences.

254. But this process of growth is connected with considerable difficulties. Until now, our Institute has not been able to obtain space in which the isotope and radiation centers must be located. We do not have the necessary space for the location of such unique equipment as the electron microscope of a completely new design, developed in the USSR, whose power almost exceeds by one factor the power of the accelerating field of microscopes commonly used in other countries. It seems to me that the new and, undoubtedly, extremely perspective problems must receive particular attention from the leadership of the Academy.

255. And, finally, a question from a completely different field — on unhealthy scientific sensationalism. That lesson which our widely-circulated press received after publishing material in connection with "discovery" refuting the second principle of thermodynamics, unfortunately, did not have the desired effect, and only recently there appeared on the pages of the widely-distributed "Literary Gazette" there appeared a similar publication from the field of biology in which it was alleged, that apparently man can assimilate mineral nitrogen from the air, that is, he could be compared to nitrogen-fixing bacteria. The article also contains other stupendous "news", which is evaluated by specialists as the fruits of absolute ignorance. But most lamentable is that the author, a correspondant for the "Literary Gazette", bases his report on Doklady Akademii Nauk SSSR /Reports of The Academy of Sciences USSR/ which contains information about similar "research". It is necessary, apparently, that "Doklady" publish only those works which are presented by academicians according to their direct specialties.

Corresponding Member AS USSR N. A. Chinakal

256. In the Academy of Sciences there exists an underestimation of technical sciences. If such new fields as rocket engineering and electronics are recognized, then as far as mining and metallurgy are concerned there immediately arises a doubt as to whether there is a place for them in the Academy or not. They say that mining science and the scientists concerned with it do not provide sufficient scientific production. Is it so? I recall that our scientists-miners, A. A. Skochinskiy, L. D. Shevyakov, and the late A. M. Terpigorev, authors of many scientific works, simultaneously actively aided

industry, and now our mining industry has taken over first place in the world in coal; there has been an increase in the mining of aluminum ores, nickel, tin, manganese. Iron ore is being mined at a rate of nearly 25% more than in the USA and we are exporting it abroad.

257. Can the Academy of Sciences, in the future, disregard such things? Of course not! Why, this is the creation of the material base for building a communist society.

258. Let us take another example — from the field of chemistry. We know that S. V. Lebedev not only developed the theory of the synthesis of synthetic rubber, but he also helped build the factory. But there are scientists who disengage themselves and call on others to follow "pure" theory, "pure" science. Undoubtedly, if a total transfer is made to theoretical research, any division of science can be moved forward, but then there arises a danger as it did in chemistry. In spite of the fact that our country was the birthplace of a number of important theoretical discoveries in the field of synthesis (I have in mind the works of N. N. Zinin and others), it turns out that we have strongly lagged in their practical application. Undoubtedly, a certain portion of this responsibility must be borne by the scientists.

259. This question is great, a principal and an important one. It is dangerous to be forced into a narrow practicalness, as has taken place in the United States, but it is also dangerous to turn away from life and recede into "pure" science. From whom should we take our example?

260. It is my opinion that it would be best to follow the example of V. I. Lenin. No one had such a genius for combining theoretical work with practical application. This liaison of theory with practice has become the guiding star of the party, of the preletariat. So may it be the guiding star for the scientists of the Academy of Sciences, guiding them to the heights of human knowledge, and the method by which the technical sciences may obtain great development in the system of the Academy of Sciences USSR.

Corresponding Member AS USSR D. D. Blagoy

261. In comparison to all of the grand successes of science and technology achieved before our eyes, that which we literary specialists do does not seem to be very significant. But this is an aberration. Our age is the age of cosmic rockets, the splitting of the atom and wise machines, but it also the age of the establishment of truly human culture. In communist society, the spiritual life of

the individual will be richer than ever before; therefore art, including the art of literature, assumes an even greater significance, and in connection with this, even the science of art and literature becomes more important.

262. Literary scholarship is on the dividing line between the Academy of Sciences and the Union of Writers. In practice this frequently leads to the fact that in the Academy of Sciences, literary scholarship is quietly believed to be within the realm of the Union of Writers and vice versa. Such a "neither fish nor fowl" attitude does not lend itself to the fruitful expansion of our science.

263. It is not normal that the institutes concerned with the study of literature be torn away from the Institute of Art History which is within another Department, that in the number of basic problems which are being processed by the Academy, there are four problems on literary scholastics but not one on art scholastics. The oblivion of the fact that literature is art is the reason for many of the distortions in the growth of our literary science, and one of the reasons that in our very own literature there appear grey, poorly done compositions. In the struggle against the formalistic conceptions of the 1920's, many went to the opposite extremes. The vulgar sociologism in its crude form was overcome long ago by Soviet literary studies, but its traces remain in the inattentiveness to the specifics of literature, to the question of artistic form which even still persists.

264. A shining symptom of the increased interest to the questions of artistic literature, style and language, is the publication of the book "On the Language of Artistic Literature" by Academician V. V. Vinogradov. This book contains a number of real questions tied in with the composition of the science of literature and the direction of its further evolution. However, the solution of these problems, as proposed by the author, in their methodological and theoretical bases is doubly discussable (for example, the proclamation of a new "particular" science of the stylistics of artistic speech — a science brought out beyond the limits of literary studies). It is necessary to have wide scientific discussions on them, not only by literary scholars and linguists, but by artists, historians, philosophers, because without the proper solution of the given problems, our science of literature can go astray and its forward progress will be impaired.

Academician K. V. Ostrovityanov

265. The proposals for changes in the organization of the Academy of Sciences, as indicated in the introductory words of

Academician A. N. Nesmeyanov, seem to me to be, basically, absolutely correct. I cannot agree with corresponding member AS USSR, N. A. Chinakal, who feels that the transfer to industry of some academic institute which is concerned with more private and branch problems is a discrimination against this institute of our science. The link between science and industry has many forms. If the Academy of Sciences USSR is concentrating its attention on fundamental, leading problems of science, it does not mean that it is tearing itself away from practice. This is evidenced by our achievements in the field of atomic energy, in the study of the Cosmos, and a number of our other achievements.

266. In the past year, scientific research work in the field of the social sciences has approached the practical in the building of communism. In this relationship, a very great role was played by the attraction of our humanitarian institutes to the development of the general perspectives of expanding the national economy. Mention should be made of the preparations made by the Institute of World Economics and International Relations of notes and a report on the rates of development of the main capitalist countries, the report of the Institute of Economics on the rates and the proportions of development of our national economy, the work of the Institutes of Law and Economics on the problems of the development of two forms of socialist property and the transition to a single communist property, studies by the Institute of Philosophy on the questions of the growth of the cultural-technical level of the working class and the kolkhoz peasantry, and overcoming the existing differences between mental and physical labor. We must also mention the fruitful participation of the Institute of Economics in the development of a methodology for determining the economic effectiveness of capital investment and the introduction of new technology — a methodology which has been approved and is already in practice.

267. The planning of national economy in the USSR is built on the basis of the application and utilization of the rules and advantages of socialist economy. But it is impossible to learn the action of economic laws and apply them to practice without considering both their qualitative and quantitative facets. Therefore, in the development of the concrete proportions of national economic expansion, of inter-branch relations, branch balances, and the balance of the national economy as a whole, the widest application of mathematics and computer engineering is demanded. Our planned economy opens, in this respect, considerably greater possibilities than the elementally developing economy of the capitalistic countries. With the correct methodological approach, from the position of Marxist-Leninist economic science, the use of mathematics and computer engineering in economics may provide a great national economic effect.

268. Great problems were placed upon the Academy of Sciences USSR as a whole and upon its humanitarian institutions in particular by the decisions of the Central Committee CPSU on the problems of party propaganda under present conditions. The Academy must actively assist in raising the scientific-technical level of our propaganda, must arm it with the results of solid study and with serious arguments against bourgeois theory.

Doctor of Historical Sciences Ya. S. Grosul

269. Undoubtedly, the head institutes of the Academy fulfilled important work during the report year. Specific and positive results were also attained in the scientific institutions of the Moldavian Branch.

270. The group of scientists of our Branch, under the leadership of professor Ya. I. Prints, for more than 12 years has been successfully conducting research in the control of phylloxera — this great scourge of viticulture, one of the leading fields of economy in our republic. As a result of this research, a system has been developed which, according to preliminary calculations, will provide over a period of 7 years, in Moldavia alone, a savings of nearly 900 million rubles. Our method is beginning to be introduced in Bulgaria and Rumania.

271. As a result of the many years of research conducted under the leadership of the late academician of the VASKhNIL, N. A. Dimo, the scientists of the Branch's Soil Institute developed a system for controlling soil erosion and utilizing slopes for orchards and vineyards by means of terracing. These measures, which have an important significance to Moldavia where slopes account for 20% of agriculturally arable land, may also be employed in other republics having similar relief and at present are being successfully introduced into the Chinese Peoples Republic and Czechoslovakia.

272. Moldavian scientists, under the leadership of professor A. Ye. Kovarskiy, have introduced two new varieties of winter wheat which in productivity surpass the regional varieties by 10-15%; a new method was developed for growing and increasing complicated hybrid varieties of corn suitable, also, for other zones of the country.

273. The republic's sovnarkhoz has accepted the suggestion of our chemists for the construction of a hydrolysis plant.

274. Our economists have developed and published scientifically based recommendations to the kolkhozes and sovkhozes of the republic on the questions of increasing the productivity of social labor and

lowering the unit cost of production, completed studies on the basic trends of technical progress in the building materials industry and in construction. The economic efficiency of the introduction of the suggestions on this question during the seven year plan will be nearly 500 million rubles.

275. We are conducting joint research with the Institute of Microbiology, the Physico-Technical Institute, and the Institute of Archeology of the Academy of Sciences USSR. Many of the outstanding scientists of the Academy have visited us on many occasions and have provided us with helpful consultations.

276. The plans for the development of the national economy of Moldavia specify the subsequent evolution and deeper growth in the Branch of scientific research in the fields of the chemistry of natural and complex compounds, the physics of semiconductors, mathematics, power engineering and automation.

Academician K. I. Satpayev

277. I would like to pause briefly on three questions. First, on the mutual relation of theory and practice, of so-called pure sciences with the applied. It seems to me that non-dialectical approaches are sometimes permitted here. Each science presents, if we can express ourselves so, a full spectrum, beginning with searches with theory, and ending with the introduction of scientific achievements into practice. To tear these parts from each other would be the same as tearing apart the whole. The Academy of Sciences USSR was and always will be confronted with the problem of the most effective aid to national economy, the possible decrease in the time element for the building of communism. And in this connection, the so-called applied technical sciences assume a special value. We should not fear that there are applied institutes in our academies; to the contrary, we should be proud of this.

278. The second question is on the situation in the Department of Geological-Geographical Sciences. The geological service and geological science cannot get by now without the methods of geophysics, geochemistry, paleontology, and stratigraphy. Meanwhile, these important parts of the body have been torn asunder in the Academy of Sciences USSR: geophysics is in the Physico-Mathematical Sciences, geochemistry is in the Department of Chemical Sciences, paleontology is in the Department of Biological Sciences, tectonics, stratigraphy and other branches are in the Department of Geological-Geographical Sciences. Keeping in mind that geology has important problems to solve, it seems to me that it would be proper to take such measures which would gather these dismembered elements into a single Department.

279. Finally, the third question — the local evolution of science. I have in mind here, Kazakhstan. As you know, this republic of ours is very vast and rich. N. S. Khrushchev correctly called it the inexhaustable storeroom of the Soviet Union. In the institutions of the Academy of Sciences of Kazakhstan and in other scientific-research centers, we are trying to solve those problems which are concerned with the development of great science in our republic. But our forces alone are insufficient. In 1959, the Presidium of the Academy of Sciences USSR provided us with considerable organizational assistance by sending to Kazakhstan very qualified, very prominent commissions of their scientists. The collective of the Kazakhstan Academy of Sciences and its Presidium have asked me to convey their warm thanks to those scientists who came to assist us and to the Presidium of the Academy of Sciences USSR which sent out this commission.

280. We trust that in the future, the ties between the Academy of Sciences USSR and the academies of sciences of the union republics, including the Kazakhstan Academy of Sciences, will be strengthened.

Academician A. A. Blagonravov

281. V. I. Lenin stated at the IV All Russian Congress of Soviets: "The summit is taken by him who has the greatest technology, discipline, organization, and best machines."

282. In the past year, the greatest successes were achieved by the institutions of the Department of Technical Sciences in those fields which are considered to be the most important from the point of view of national economy requirements: power engineering and power machine building, the derivation and application of new materials, metals, and alloys, radio engineering and electronics, automation and telemechanics, mechanics, new technological processes and an intensification of the existing ones with the aim of increasing the productivity of labor. Active participation was taken by the Department in the solution of problems concerning the study of cosmic space, the problem of semiconductors, etc.

283. Up to the present, however, discussions are still going on as to which scientific directions must be considered the most important and which of them are worthy of study by the Academy of Sciences. It seems to me that the only criterion in determining the most important directions is their relationship to the basic problems of the scientific, technical, and cultural evolution of the country with the goal of building a communist society.

284. Perhaps more important for the Department of Technical Sciences than for any other Department is the coordination of the work along the entire scientific front, inasmuch as the activities of the wide net of industrial scientific institutions is closely tied in with the work of the academic institutions. One cannot divide science into academic and non-academic. A single concept must exist — Soviet science. We must not be concerned with delimitation, but rather with the correct concentration of efforts.

285. I agree with Academician A. L. Mints that the academic institutions should have a preponderance of works having a research-planning character, but one should not exclude the fact that in required instances they should be carried out to the development of concrete objectives. It is incorrect to call such works "branch type". Technical sciences in its research equally uses both deductive and inductive methods. For example, in metallurgy one goes from the study of physico-chemical laws to the development of proposals for specific alloys, while in automation, the evolution of theoretical disciplines preceeds experimental work with specific objects.

286. The activity of the Department of Technical Sciences cannot be evaluated only as the total activity of the institutes which comprise it. We must also consider those great achievements which were obtained by members of the Department in the non-academic network, for example, on the problems of aircraft construction, rocket construction, etc. I think that in the future the work of these scientists must be more closely linked with the academic institutions.

Academician A. F. Ioffe

287. I would like to make one small remark. I think that the very important question of the participation of Soviet science in the evolution of world science has not been given enough space in the report. I consider it my duty to talk about this because I was one of the first persons whom V. I. Lenin sent overseas for the re-establishment of scientific ties and it was necessary for me to give consideration to and actively promote this work.

288. Permit me to tell you of those two fields of scientific work in which I directly participated. One of them was on semiconductors. At the present time a sharp change is taking place in this field of science which is lifting it to new levels. Our conception of semiconductors has become many times more complicated. Naturally, the new conceptions open new practical possibilities. In particular, we long ago posed the problem of a power use for

semiconductors for the direct conversion of thermal energy into electrical. The concepts which we are beginning to employ permit us to take great forward strides. It turns out now, that in utilizing solid semiconductors, it is possible to obtain approximately 15% efficiency (instead of 8% which we have had), and by using gases or vacuum at 2000° C., it is about 60%.

289. In this manner, in power engineering, in refrigeration work, a completely new stage is evolving, very intriguing possibilities are being opened in the uses of energy sources. This is only one of the many sectors of semiconductor science and technology which is now being expanded rapidly.

290. The other field is the use of the achievements in physics not only for industry but in agriculture. I will give you one result which was obtained comparatively recently. Through the use of accurate equipment, there was completed a special study on the requirements of plant life to external conditions (primarily for light) which showed that wherever there is energy it is possible to obtain agricultural products. In particular, for example, it became evident that in cultivating tomatoes, 2-2.5 less time is required than that which had been long established by agronomical science. In 60 days, from a one square meter surface lighted by an electric light it is possible to obtain approximately 17 kilograms of vegetables and their cost is determined, primarily, by the cost of electrical energy. In the future, it will be possible to supply all of Siberia, right up to the Far North, with vegetables and berries all your round at very low costs, since electrical energy will be comparatively cheap there.

291. These fascinating ideas are far from fantastic; they await their fulfillment.

Corresponding Member AS USSR V. M. Khvostov

292. Adhering to the directives of the XXI Congress of the party and bringing to life the decisions of the last Annual Meeting of the Academy, the Institute of History considerably re-oriented its activities in order to facilitate the rise of the more essential branches of historical science (history of socialist society and the most recent history of the capitalistic countries) and to obtain a concentration of research efforts on the most important scientific directions. At the present time, there has been included in the basic activity of the Institute, several important tasks which have a considerable scientific and practical significance. This was, first of all, the creation (for the 50th Anniversary of the Great October Socialistic Revolution) of a multi-volume academic "History

of the USSR (From the Ancient to the Present Time)" in which there must be summed up an enormous amount of personal monographic studies, the Marxist-Leninist concepts of the history of our country must be included, and a generalization made of the results of building socialism and communism in the USSR. Simultaneously, the Institute is preparing a short scientific-popular book on the history of the USSR designed not only for the Soviet but also for the foreign reader and having as its aim the countering of the bourgeois falsification of our Homeland's history with the historical truth. With the attraction of the scientific institutions of the union republics and under the guidance of the Scientific Council on the problem, the preparation for the writing of the scientific history of the Great October Socialist Revolution is underway. The struggle against inimical ideologies is growing. The Institute has already published a number of collected works devoted to the struggle against bourgeois and revisionist historiographies, and is preparing new ones.

293. There will be an expansion of research in the field of study of the history of religion and atheism. A work is being prepared on Christian socialism — one of the basic trends of the modern ideology of the capitalistic world. A rather significant work has been written on the battle against religious sectarianism in our country. A scientific history on the Second International, a generalized work on the newest history of the international workers movement, and several text books for VUZes and secondary schools are also underway. Outlines on the history of the Latin American countries will fill an existing gap, in this relation, in Marxist historical literature.

294. The year's experience has shown that in the field of the social sciences, the scientific work of the Academy is being properly planned. However, in order to solve the existing problems which still face us, it is necessary to improve the coordination of work of all three humanitarian Departments.

295. The development of social sciences is being hindered by a deficiency of scientific information. That which we are doing is still, in this sense, primitive and incomplete, and reviews of foreign literature are still being conducted unsystematically. This hampers the battle against bourgeois ideology and lowers the level of scientific production.

296. Serious defects exist in the activity of the academic publishing house and in "Akadem Knigi". Frequently, valuable scientific works are published with limited circulation which results in an increased cost of the books, their unprofitability and, most important, they do not reach the readers in the peripheral areas.

Academician V. A. Ambartsumyan

297. The stress on difficult problems with which our Academy of Sciences USSR and the science of our country as well is concerned was correctly presented in the report. But the report does not contain an evaluation of the level at which we solve these problems. I have gained the impression that in many fields, we are still not conducting work at the level necessary for the solution of scientific problems at the tempo demanded by our country today.

298. For example, we can be proud of the great achievements made in astronomy in the study of the physics of the Sun obtained through the work of the Crimean Observatory. There are also a number of achievements in radio astronomy. But we lag by quite a bit in the development of one of the most important problems of astronomy: the study of the galaxy and the extra-galactic world. The reason for this lag is that we still do not have very large telescopes. Within recent times, great strides were made in the establishment of such an observation base: the construction of one of the largest telescopes in our land, having a mirror diameter of 2.6 m., is in the process of completion; it will be located in the Pulkov Observatory. Another telescope being completed has a wide field and an aperture diameter of 1 m., which will permit inspection of a wide celestial area. The Pulkov Observatory conducted extremely valuable works in the establishment of a very technically progressive project for a 240 inch telescope (the world's largest), and made a number of successful technological solutions. The completion of this telescope in the shortest period of time will permit us to overcome the lag in the study of the problems of extra-galactic astronomy and stellar spectra.

299. Further, I would like to talk about the problems of the union republic academies of sciences.

300. The work which is being advanced by the requirements of national economy of one republic or another, frequently results in significant achievements in the field of theoretical science as well. As an example, we can use the work of the Academy of Sciences of Kazakh SSR in the field of geology; it is tied in very closely with the solution of concrete problems, but nevertheless, it raises the geological science of our country to a higher level.

301. At the present time, the republic academies have a basis for the completion of a considerable portion of the activity along the principal fundamental problems. Therefore, we must strive for the academies to promote even deeper fundamental activities in those directions which correspond to the solution of the national economic problems of the given republic.

302. We have all that is necessary to convert the republic academies into major scientific centers. To provide them with suitable cadres, it seems to me to be of the utmost importance to extend the proposed regulation concerning an institute of probationary personnel in the scientific institutions of the Academy of Sciences USSR to the republic academies.

Corresponding Member AS USSR P. A. Baranov

303. The report on the activities of the Academy for 1959 to which we have listened did not mention the basic biological sciences -- botany and zoology. Perhaps if we had made achievements in the field of astrophysics and had studied the vegetative cover of Mars and Venus, then they would have been mentioned. But thus far, we have been expending all of our efforts and attention to our own planet, to its great and rich vegetative cover whose study is constantly resulting in the attainment of important results for the national economy.

304. In 1959, the regularly published volume "Flory SSSR" /Flora of the USSR/ was issued and, in addition, five other volumes of "Flor" /Flora/ were published by the republic academies of sciences. The publication of the regular "Flory" volume of any country is a great occurance and mentioned in the entire world's botanical literature. According to the acknowledgement of foreign botanists, Soviet floral and geobotanical works occupy one of the foremost places in the world. A leading place belongs also to Soviet botanical cartography.

305. In connection with the XXI Party Congress, we have in the recent past, concentrated our attention on providing the results of the study of the vegetative growth of the USSR in the interests of raising the fodder base for stock raising. It is known that 3/4 of the fodder balance in the stock raising of the USSR is provided by natural meadows and pastures. They have been very carefully studied for many years by Soviet botanists. On 10 February of this year, a visiting session of the Bureau of the Department of Biological Sciences was held in Leningrad (I might mention that we Leningradians warmly welcome this new form of bringing the work of the Department to the institutes) in the decision was made to entrust the Botanical Institute, together with the VASKhNIL, SOPS /Sovet po izucheviyu proizvoditel'nykh sil — Council for the Study of Productives Forces/ and the Ministry of Agriculture USSR with the development of proposal encompassing the entire aggregate of recommended measures on the reconstruction of the natural fodder base of stock raising.

306. Our institute devotes considerable attention to the study of physiologically active substances of vegetative origin and, in particular, to the search for sources of triterpene compounds which, in their properties, are close to steroid hormones, and a number of other substances of hormonal action which may be employed in the treatment of serious diseases such as radiation sickness, malignant tumors, leucoderma and others.

307. Our institute, which was formed under Peter I and has inherited its structure from the past, was reexamined in the report year on the basis of recommendations made at the general meetings last year by the Academy and the Department of Biological Sciences. We feel that this will give positive results.

308. It could be hoped that there would be a more rapid introduction into our science of the methods of physics and chemistry. Therefore, we petition the Presidium, when facilities are being distributed, to give special consideration to the requirements of such old institutions as the Zoological and Botanical institutes in regard to acquisition and modernization of equipment. We particularly hope that the Leningrad institutions will receive their due attention from the Presidium in the distribution of funds for construction as well.

Academician V. A. Kargin

309. The fate of the works in the field of high molecular compounds, a role which was so vividly underscored in the decisions of the May Plenum of the Central Committee CPSU 1958, was instructive for the Academy because it was reiterated in a newer form to a considerable degree and their scope in the past year has increased approximately 2.5-3 times.

310. The science of polymers is composed of a number of studies whose processing is necessary for its harmonic growth. One of these fields is concerned with obtaining of initial, low molecular substances (monomers); the second is the research concerning their polymerization into high molecular compounds; and, finally, the third is the study of their structure and properties; the final goal of these studies is that of facilitating the search for new methods of processing polymers into articles.

311. Even two years ago in the Academy of Sciences USSR the science of polymers was not evolving smoothly. Since then, however, this irregularity has been significantly eliminated. The Institute of Chemical Physics, the Institute of Organo-Elemental Compounds, and the Institute of Petrochemical Synthesis, have employed

broad research on obtaining monomers and their polymerization. The situation is worse in the field of work concerning the processes of the treatment of polymers and their utilization, a field in which close liaison must be sought between the chemists and the Department of Technical Sciences, and, first of all, with the Institute of Machine Studies.

312. The Institute of High Molecular Compounds, which has high personnel reserves and capabilities, conducts a number of very good independent works but it has a definite lack of any basic direction concerning the major problems in the field of high molecular compounds. It seems to me that the Presidium of the Academy should entrust this institute with the development of one of these problems. Concerning the Institute of Physical Chemistry, it has taken upon itself, along the principles mentioned above, the research which concerns high molecular compounds. It has taken up the question of coatings and we are now sure that the Institute is working precisely in this field.

313. It would be desireable if the Presidium would clarify the degree to which research being conducted on high molecular compounds reflects the interests of the development of this entire branch of science and not the personal interests of one scientist or another. This will permit the deployment of effort in the most important directions.

Corresponding Member AS USSR P. N. Fedoseyev

314. We are proud of our scientific achievements which are acknowledged even by those who are unfriendly to us. The science of the Soviet Union has attained these successes by virtue of the socialistic social structure with its planned economic organization and its smooth evolution of research, by virtue of the enormous increase in the cultural level of the population and the broad expanse for the growth of scientific effort from the people. The great advantage of Soviet science is also the result of its being equipped with advanced Marxist-Leninist ideology. Dialectical materialism gives to science powerful means of synthetic generalizations which are unattainable by the fashionable, in the West, one-sided and narrow philosophical positivism. The fertility of the union of natural science and philosophy has been evidenced by the Academy's conference on the philosophical questions of natural science which permitted the solution of a number of difficult questions of contemporary science, for example, the question of causation. We anticipate the organization of theoretical conferences on the philosophical questions of the physics of elementary particles, the physiology of higher nervous activity and psychology, the creation

of fundamental tasks in which, on the basis of a materialistic generalization of the newest data from all of science, the most modern picture of the world may be composed.

315. For the solution of similarly important problems, it is necessary to take steps for the training of cadres in the philosophy of natural science, and, moreover, such cadres must be trained not only by the philosophical institutions, but also by those of the natural sciences.

316. There has recently been a healthy contact between the economists and the personnel in the technical sciences. This was evidenced by the execution of technical-economic studies on the questions of automation, on the problem of the effectiveness of capital investment and new technology. However, one cannot say that the contacts between the economists and the specialists in the field of technical disciplines in our Academy are sufficient; we must think about strengthening the coordination of research on technical-economic problems, and possibly create, for these purposes, a special coordinating council or several such councils, designate a series of directions for joint work in this field, devote serious attention to the training of scientific cadres which are well acquainted with both technology and economy. In connection with the work now being performed in the field of the use of mathematical methods in economic research, it is also necessary to train the required specialists.

Corresponding Member AS USSR Yu. G. Mamedaliyev

317. I consider it my duty to call the attention of the General Meeting to a particularly fruitful performance of joint research by the institutions of the Academy of Sciences USSR and the union republic academies of sciences for the solution of major scientific problems having a major significance for the national economy. The collective development of such problems through the application of individual bright talents gives the most important results from the viewpoint of both theory and practical application. I will give you several examples.

318. Among the mineral deposits of our republic, one of the most important is the complex aluminum ore alunite of the Zaglik ore fields. The problem of the industrial use of the Zaglik alunites for the development of the aluminum industry of the country was successfully solved only recently, when a creative group of scientists of the All-Union Aluminum-Magnesium Institute, the Institute of Petrochemical Processes of the Academy of Sciences Azerbaydzhan SSR, the Kirovabad Alumina Plant of the Azerbaydzhan Sovnarkhoz, and

the Azneftoproyekt [Azerbaydzhan Petroleum Project] developed an effective technological method of sintering and reducing alunites in a fluidized bed. This technological process is distinguished by its simplicity and ease of control and provides, together with alumina, of a considerable amount of by-products: sulfuric acid, potassium fertilizers, and a number of rare elements. A factory is under construction in Azerbaydzhan for the production of alumina and it will be not only one of the largest in the USSR but the first in the world to use alunites.

319. The Academy of Sciences of Azerbaydzhan SSR, in close contact with the Institute of Petrochemistry Synthesis of the Academy of Sciences USSR, is conducting a great complex of studies in the field of the synthesis of additives, used in improving the quality of lubricating oils. Tentative calculations indicate that the use of only the one form of additive proposed by the Academy of Sciences Azerbaydzhan SSR will permit a savings of hundreds of millions of rubles annually.

320. In a group effort, the scientists of the Institute of Organic Chemistry of the Academy of Sciences USSR, the Institue of Petrochemical Processes of the Academy of Sciences Azerbaydzhan SSR, and the Scientific Research Institute of Synthetic Rubber have developed a technique for producing butadiene from butane and butylene which, at the present time, is in the stage of major industrial introduction in three economic regions of the country.

321. In giving you these few examples, whose number could be considerably increased, I had in mind the posing of the question on the need for further significant expansion of the scale of joint cooperation on major problems by the union republic academies of sciences, and by them and the Academy of Sciences USSR. Until now, the remarkable possibilities of this progressive method of collective creation are being far from fully utilized.

Academician M. M. Shemyakin

322. The bordering problem of chemistry and biology — the chemistry of natural and biologically active compounds — was included by the Presidium of the Academy in the number of the most important problems of the seven-year plan for the development of science. Its significance was particularly mentioned in the decisions of the May Plenum of the Central Committee CPSU 1958. This branch of science, one of the leading divisions of organic chemistry, determines the development of many basic disciplines of the medical-biological cycle and has a strong influence on the solution of a number of important practical problems of health, agriculture and industry.

323. Unfortunately, the growth of the chemistry of natural and biologically important compounds sharply lagged in the Soviet Union for quite some time, but in the past 2-3 years this situation has been essentially changed and the work on certain divisions of this field of knowledge is now being conducted in a number of laboratories and institutes. Of considerable importance was the establishment, in 1959, of the Institute of Chemistry of Natural Compounds of the Academy of Sciences USSR.

324. A large number of the Institute's laboratories, especially those which were transferred from other institutes of the Academy of Sciences USSR, have already begun to function. Initial successes have been realized. But there is still much to be done before the Institute can fully develop its activities. We should attain, in the shortest period of time, a position in which the space and equipment of the Institute meets the most modern requirements, so that it will have all of the necessary equipment and instruments, including experimental-productive installations for the isolation and purification of natural compounds, which will permit the production of research items in sufficient quantities.

325. The work on the chemistry of natural compounds must be conducted as well in other institutes of the Academy of Sciences USSR and in the union republic academies of sciences, in the Academy of Medical Science USSR, in the institutes of the Ministry of Health, and in the Ministry of Agriculture USSR. In so doing, attention must be given to the development, first of all, of the most important areas - chemistry of protein and peptides, carbohydrates, nucleotides, antibiotics, steroids, terpenes.

Corresponding Member AS USSR L. R. Neyman

326. Appearing at the All-Union Conference on Power Engineering Construction in November 1959, N. S. Khrushchev indicated that the problems of electrification, the construction of high-energy power systems, the problems of developing a material-technical base for communism, must be the main ones in our party's program.

327. The Academy of Sciences USSR must give a scientific basis to the perspective plan of the country's electridication over 15-20 years. Participating in the development of this problem are the Power Engineering Institute imeni G. M. Krzhizhanovskiy, the Institute of Electromechanics, as well as other institutions of the Academy of Sciences USSR and, practically, all of the union republic academies of sciences.

328. The complexity, importance, and great scale of work is apparent from the following figures. In 1959 our country took over second place in the world in the production of electrical energy, reaching a level of 260 billion kilowatt/hours and giving way only to the USA. Projected for 1965 is the production of 500-520 billion kilowatt/hours, for 1970 - 900 billion, for 1975 - 1500 billion, and for 1980 - 2300 billion kilowatt/hours.

329. It is evident that we can fulfill and overfulfill this grandiose program, thereby winning the competition with the capitalist world in this most important sector, only by solving the problem at the highest scientific level, by using the most modern achievements in physics, chemistry, metallurgy, mechanics, automation, and electronics, and by finding the optimum solutions on the basis of our economic science.

330. In the solution of a number of problems, the USSR has already assumed first place. Soviet factories are capable of producing hydroelectric equipment of 200-500 thousand kilowatts. The Institute of Electromechanics has conducted research on the preliminary design of turbogenerators with a power of up to 750-1000 thousand kilowatts. The Power Engineering Institute and the Institute of Electromechanics are solving the problem of the creation of super-powerful long-distance electrical transmission lines which are needed for the establishment of a Single Power System for the Soviet Union. The required electrical transmissions from Siberia to the Urals with a power of nearly 10 million kilowatts over a distance of 200 kilometers may be technically and economically realized only by means of employing the latest progressive type of transmission of a super-high direct current voltage on the order of 1200-1400 thousand volts. The Soviet Union also is in first place in the world in the process of solving this problem.

331. Wide perspectives may open the creation of really economical atomic electric power stations developed along new principles. Particularly significant are the daring searches for new sources of energy and new highly effective methods for its conversion.

332. The problem of the development of power engineering and the complete electrification of our country with all of the multiplicity of its complicated scientific tasks requires an unweakening attention by the Academy and must be one of the leading, I would say, fundamental of its problems.

Corresponding Member AS USSR N. V. Mel'nikov

333. The detailed report of the Presidium shows the great work of the members of the Academy of Sciences and of its institutions.

But the report says nothing about one of the most important works having a first rate significance for the national economy. I have in mind the work of scholars on state consultations. The Council of Technical-Economic Expertise of Gosplan USSR consists of 35 well known specialists, many of them members of the Academy of Sciences.

334. In the course of the fulfillment of the seven-year and the yearly plans, problems arise which require a technical-economic evaluation, for example, for the solution of the question of the expediency of the equipping of hydroelectric power stations, the selection of the type of electrical transmission, the construction of enterprises, railroads, etc.

335. In 1959, 150 scientific workers of the Academy of Sciences participated in the solution of 55 consultation questions. This responsible work, linking the scientists directly with life and permitting them to utilize their high knowledge for the solution of the most important questions in the building of the material base of communist society, should have been reflected in the report.

336. The second question is the study of the productive forces of the country. As you all know, V. I. Lenin devoted considerable attention to this problem in his "Nabrosok plana nauchno-tekhnicheskikh rabot" /Draft of the Plan of Scientific-Technical Works/. With a study of the productive forces, one directly ties in geology, mining, and a number of other sciences. Therefore, the Academy, as a complex scientific institution whose tasks include the constant study of productive forces, must have all of these sciences within it and must expand them.

337. Mining science has the possibility of studying, through direct exploitation of deposits, the stress condition of rocks, their pressure, the ejection of coal and gas, etc., and in this area it supplements geology and facilitates the study of the mineral resources.

338. The second part of mining science refers to technical sciences. Here, through its studies, it has a great influence on the growth of the national economy. The main goal of mining science is the establishment of scientific foundations for complex-mechanization and automation of mines in which high productivity of labor will be achieved and its safety ensured.

339. From the fascinating speech of corresponding member AS USSR L. A. Zenkevich on the possibilities of studying the deposits of useful minerals on the bottom of the ocean, it becomes evident that only through the aid of mining science will it be possible to bring this study to its logical conclusion, i.e., to the methods of processing such deposits.

340. Mining science is a difficult, complicated science. It is directly tied in with the study of the productive forces of the country and with the expansion of national economy. And that is why it must be developed by the Academy of Sciences USSR.

Corresponding Member AS USSR N. P. Sazhin

341. For science and technology, semiconductors are correctly called problem #2. Thanks to the efforts of Academician A. F. Ioffe, the physical side of this problem is sufficiently well known. I will pause on another, less known, but no less important part of this problem - the metallurgy of semiconductors.

342. The semiconductor properties of various materials become apparent only at a specific, generally very high degree of purity. Therefore, from the metallurgical viewpoint, the semiconductor problem is in part a more common problem — obtaining metals (elements, more correctly) of an ultra-high purity. At the present time, for some pure metals, an impurity, consisting of a hundred thousandth or even millionth part of a percent, is a reason for rejection. For example, in germanium used for the production of triodes, the copper admixture must not be more than 1.10^{-7}%, which is a milligram of copper to a ton of germanium.

343. To obtain metals with such a high purity, use is made of completely new, at times very complicated metallurgical methods and equipment. The industry of semiconductor devices requires a wide and rapid execution of research work on metallurgy. An improper evaluation of the role of metallurgy in the problem of semiconductors can be, at the least, sharply reflected in the evolution of this important problem. The institutes of the Academy of Sciences must strengthen their work on the sensitive methods of analysis of admixtures in semiconductor materials.

344. Besides the high purity, semiconductor materials must have single crystals with a limited number of so-called dislocations, i.e., imperfections in the crystal lattice. In the solution of this problem, important assistance must be provided by the Institute of Crystallography.

345. Concerning theoretical work on metallurgy, this field should have eliminated from it the completely unnormal situation observed in a number of institutes, where such work, unfortunately, is considered to be tasks of "a second sort". The Institute of Metallurgy, first of all, must be concerned with theoretical work without which it is impossible to expand practical metallurgy, especially in the development of new technological processes.

346. On the question of coordinating research activities, it is my opinion that it is necessary to create an authoritative group which would not only point out the unnecessary parallelism in the work, but also would be able to stop it.

347. My last remark: to my point of view, the report on the activity of the Academy for 1959 does not sufficiently reflect the role of its institutes in the organization of the production of a metal of great importance — titanium. At the present time there has been established in the Soviet Union an industry for high-quality metallic titanium.

348. In addition to the coordination of research activities on titanium which was very successfully conducted by Academician I. P. Bardin, the Institute of Metallurgy participated in the development of a number of problems on the metallurgy of titanium, and this should have been mentioned in the report.

Academician Ye. N. Pavlovskiy

349. I would like to share several comforting impressions. A fresh wind blew in the Department of Biological Sciences: they have begun to conduct visiting sessions of the Department's Bureau in Leningrad, one session was held at the Zoological Institute, the other was held at the Botanical Institute. There is no need to discuss the usefullness of this measure; one should only express the hope that this practice will continue.

350. It is very gratifying that the scientific societies existing within the Academy of Sciences have brought upon themselves due attention. This is evident if from nothing more that the characteristics of its most important activities are already included in the annual report of the Academy. Scientific societies are the connecting link between the general headquarters of Soviet science, which is the Academy, and the mass of scientists working outside of the system of its institutions and scattered all over the country; their activities, to a considerable degree, facilitate a more improved planning and coordination of science. The Geographic Society of the USSR had its regular congress in the beginning of February in Kiev; it was attended by many individuals and was characterized by enthusiastic participation. The Congress of the All-Union Entomological Society was recently held in Leningrad and concided with the 100th anniversary of the activity of this society. Such congresses attract society members from the most distant places.

351. Comforting impressions were obtained during my visits to the Institutes of Zoology and Parasitology of the Academy of

Sciences Kazakh SSR in Alma Ata and the Academy of Sciences Tadzhik SSR in Stalinabad.

352. The section on parasitology of the Alma-Ata institute has an out-of-town area which is well equipped and which has an unprecedented nursery for experimental animals. Here you will find wolves, foxes, deer, bear cubs, smaller animals and many wild birds, not to mention farm animals.

353. The Institute of Zoology and Parasitology of the Academy of Sciences Tadzhik SSR also received an out-of-town base with good quarters.

354. I would like to express the desire that our "old" institutes, particularly the Zoological Institute with its museum, be improved, particularly in regards to space, equipment, etc., so that it would conform with contemporary requirements and contemporary science, corresponding to their scientific and scientific-propagandistic problems.

RESOLUTIONS OF THE GENERAL MEETING

355. On the basis of the report of the acting chief scientific secretary of the Academy of Sciences USSR, corresponding member AS USSR, Ye. K. Fedorov, and the subsequent discussions, the General meeting made the following resolutions.

356. "The report year was the most important historical boundary in the life of our country, stepping forward into a new period of its development -- the period of the extensive building of communism.

357. "Soviet science has expanded in the past year under the banner of the historical decisions of the XXI Congress CPSU which projected a grandiose program for building communism in the USSR.

358. "The year 1959 was marked by great successes of Soviet science and technology. By virtue of the flight of three cosmic rockets, new brilliant results have been attained in the understanding of the Universe.

359. "Guided by the decisions of the XXI Congress CPSU, the Academy of Sciences USSR, in the report year, concentrated its forces, first of all, on the organization and realization of scientific activity as indicated in 'Osnovnyye napravleniya nauchnykh issledovaniy na 1959-1965 gg.' /The Basic Directions of Scientific Research for 1959-1965/, on the development of problematics arising

from these directions, on the rebuilding of the activities of the academic institutions and improving the structure of the Academy in accordance with the missions assigned to Soviet science by the party.

360. "An important meaning for the development of biological science was contained in the decisions of the Plenums of the Central Committee CPSU on the further development of agriculture. They were the bases for the reorganization of the work of the Department of Biological Sciences, conducted in 1959, in the direction of solving the more vital theoretical problems and simultaneously for a closer liaison between the academic scientific institutions of the biological area and the practical side of agriculture and medicine.

361. "The June Plenum of the Central Committee CPSU placed before the Academy of Sciences USSR, as the most important problem, the further creative expansion of science and technology in an unbroken tie with the practice of communist construction. Its decisions on the measures for expediting technological progress permitted the establishment of a course of further expansion of scientific research by the Academy of Sciences in this direction.

362. "The resolutions of the 9 January 1960 Central Committee CPSU 'Ozadachakh partiynoy propagandy v sovremennykh usloviyakh' /On the Problems of Party Propaganda Under Modern Conditions/ contain new important problems for the workers in the social sciences, the solution of which must fall within the basic activities of the humanitarian institutes of the Academy of Sciences USSR.

363. "In noting the major achievements of Soviet science, the General Meeting of the Academy of Sciences USSR considers that in a number of scientific research fields, there is still a nonconformity between the growing problems, advanced by the requirements of the country in the epoch of extensive building of communism, and the attained level of scientific work. Therefore, a further energetic effort to raise the scientific research levels is necessary.

364. "The General Meeting of the Academy of Sciences USSR decrees:

365. 1. To approve the report of the Academy of Sciences USSR on the 1959 activities, having charged the Presidium of the Academy to append, after final editing, the additional remarks made during the discussions to the written text of the report.

366. 2. To approve the activity of the Presidium of the Academy and to suggest that it considers in its practical work, the

criticisms of the General meeting directed to the Presidium and to the Academy's institutions."

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367. On the basis of secret balloting, in accordance with the corresponding points in the Regulations of the Academy of Sciences USSR, the General meeting has accepted the following decrees.

368. Academician M. V. Keldysh is elected vice president of the Academy of Sciences USSR.

369. Academicians-secretaries, elected by the departments of the Academy of Sciences USSR, are approved:

Department of Physicomathematical Sciences — Academician L. A. Artsimovich,

Department of Chemical Sciences — Academician N. N. Semenov,

Department of Geological-Geographical Sciences — Academician D. I. Shcherbakov,

Department of Technical Sciences — Academician A. A. Blagonravov,

Department of Literature and Language — Academician V. V. Vinogradov,

370. Elected as members of the Presidium of the Academy of Sciences USSR: Academician V. A. Ambartsumyan, Academician A. P. Aleksandrov, Academician A. Ye. Arbuzov, Academician M. M. Dubinin. Academician P. L. Kapitsa, Academician M. P. Kostenko, Academician A. L. Kursanov, Academician N. I. Muskhelishvili, Academician A. V. Palladin, Academician I. G. Petrovskiy, Academician K. I. Satpayev.

371. The General meeting confirmed as directors of the scientific institutions of the Academy both those elected by the departments for a new term and those elected for the first time.

372. Confirmed as directors in accordance with the resolutions of the Meeting:

For the Department of Chemical Sciences:

Institute of Geochemistry and Analytical Chemistry imeni V. I. Vernadskiy — Academician A. P. Vinogradov,

Institute of Chemical Physics — Academician N. N. Semenov,

Institute of Physical Chemistry — Academician V. I. Spitsyn,

Institute of General and Inorganic Chemistry imeni N. S. Kurnakov — Academician I. I. Chernyayev,

Hydrochemical Institute — corresponding member AS USSR — G. A. Alekin,

Radium Institute imeni V. G. Khlopin — corresponding member AS USSR V. M. Vdovenko,

Institute of the Chemistry of Natural Compounds — Academician M. M. Shemyakin;

For the Department of Geological-Geographical Sciences:

Institute of Oceanology — Doctor of Geographical Sciences V. G. Kort,

Laboratory of Coal Geology — Doctor of Geological-Mineralogical Sciences V. V. Mokrinskiy;

For the Department of Biological Sciences:

Institute of Genetics — Academician T. D. Lysenko,

Institute of Microbiology — corresponding member AS USSR A. A. Imshenetskiy,

Sevastopol Biological Station imeni A. O. Kovalevskiy — Doctor of Biological Sciences V. A. Vodyanitskiy,

Laboratory of Forest Studies — Academician V. N. Sukachev,

Institute of Radiation and Physico-Chemical Biology — Academician V. A. Engel'gardt,

Institute of Physiology imeni I. P. Pavlov — corresponding member AS USSR V. N. Chernigovskiy,

Institute of Forestry and Forest Chemistry — Doctor of Agricultural Sciences I. S. Melekhov,

Institute of the Higher Nervous Activity — Doctor of Biological Sciences V. S. Rusinov,

Institute of Cytology — Doctor of Biological Sciences A. S. Troshin,

Institute of Biological Physics — Doctor of Biological Sciences G. M. Frank;

For the Department of Technical Sciences:

Institute of Electromechanics — Academician M. P. Kostenko,

Power Engineering Institute imeni G. M. Krzhizhanovskiy — corresponding member AS USSR G. N. Kruzhilin;

For the Department of Historical Sciences:

Institute of Oriental Studies — corresponding member AS USSR B. G. Gafurov,

Museum of the History of Religion and Atheism — Doctor of Historical Sciences S. I. Kovalev,

Institute on African Studies — Doctor of Historical Sciences I. I. Potekhin,

Institute of Sinology — Doctor of Historical Sciences S. L. Tikhvinskiy,

Institute of Slavonic Studies — Candidate of Historical Sciences I. I. Udal'tsov;

For the Department of Economic, Philosophical, and Legal Sciences:

Institute of World Economics and International Relations — corresponding member AS USSR A. A. Arzumanyan,

Institute of Economics — Doctor of Economic Sciences K. N. Plotnikov;

For the Department of Literature and Language:

Institute of World Literature imeni A. M. Gorikiy — Doctor of Philological Sciences I. I. Anikinov.

Institute of Russian Literature (Pushkin House) — Doctor of Philological Sciences A. S. Bushmin;

For the Siberian Department:

Institute of Geography of the Siberian Department — corresponding member AS USSR V. B. Sochava.

Confirmed as Chairman of the Presidium of the Bashkir Affiliate of the Academy of Sciences USSR: Doctor of Chemical Sciences R. D. Obolentsev.

373. The General meeting confirmed as directors:

Doctor of Technical Sciences A. I. Mikhaylov for the All-Union Institute of Scientific and Technological Information of the State Scientific-Technical Committee of the Council of Ministers USSR and the Academy of Sciences USSR.

Doctor of Chemical Sciences N. A. Figurovskiy for the Institute of the History of Natural Sciences and Engineering of the Academy of Sciences USSR.

QUANTUM RADIOPHYSICS

(Speech of Doctor of Physicomathematical Sciences N. G. Basov and Doctor of Physicomathematical Sciences A. M. Prokhorov)

374. All of us are witnesses of the extremely vigorous development of radio engineering and electronics. Radio, television, radar, radio navigation, remote control, electronic computers, and many other things which have been able to enter firmly into our life and customs visibly demonstrate the power of contemporary radio engineering.

375. At first glance, it might seem that there are no limits to the possibilities of electronics and that it is possible, for example, to develop receivers which could pick up even the weakest signals. But actually, this is not so. In each radio tube, in each wire, because of the chaotic thermal movement of electrons, random current oscillations develop which cause, what radio engineers call, set "noise" in the radio receiver. And if the signal arriving at the receiver input is weaker than this noise, then regardless of how we amplify this signal or how many tubes we use, the noise will be amplified together with the signal and the signal will be drowned in the noise. This phenomenon has greatly limited the possibilities of radio engineering.

376. Each of us who has ever used a radio receiver came against still another difficulty: the received stations would "creep" one on top of another. Such interferences created close to the operating

stations may be the result of the transmitter's having an insufficiently high stability and it "enters" into another's frequency band. Many radio engineering problems require the use of oscillators having high frequency stability. For example, the exact calculation of distances through the use of radio range finders is impossible without high-stability oscillators.

377. Just recently we have seen with our own eyes the wide introduction of semiconductor devices. Semiconductors have permitted the solution of a number of important problems. However, the common semiconductor devices did not overcome the above-mentioned difficulties. To decrease thermal noises, the value of which is proportional to temperature, it was necessary to "cool" the receivers. But neither electron tubes nor semiconductor devices could operate at low temperatures.

378. Great difficulties also arose in the development of frequency-stable oscillators, since the stability of the best quartz oscillators did not satisfy technology.

379. Several years ago, new methods were discovered in radio engineering which open vast possibilities for the amplification of extremely weak signals and the generation of exceptionally stable radio wave frequencies. For this purpose, it was necessary to introduce the concepts of quantum radio emission into radio engineering.

380. As we know, light and all electromagnetic oscillations in general are absorbed and emitted by quanta. The value of a quantum is equal to hv, where h is the Planck constant and v is the emission frequency. All spectroscopy, atomic and nuclear physics, as well as chemistry, are based on the concepts of quanta, but in radio engineering quantum concepts have, for a long time found no application. This is explained, first of all, by the fact that in the majority of processes which are examined in radio engineering there is usually involved a very significant number of quanta of an electromagnetic field, as a result of which these processes are well described by classical averaged valves and, for practical purposes, do not involve elementary cases of interaction of the individual quanta with the individual atoms.

381. Only since the 1940's in conjunction with the development of a new branch of physics — radiospectroscopy, which studies the spectra of various substances in the radio frequency waveband — has there begun a utilization of quantum mechanics: the theory of the spectra of gaseous, liquid, and solid matter, the theory of relaxation processes in such matter, as well as the theory of the interaction of field quanta with matter (the effect of saturation, spontaneous emissions), and others are receiving their further evolution.

382. New and important phenomena were discovered in the 1940's: nuclear magnetic resonance and electron resonance. Radio-spectroscopy of gases received wide development, a series of new effective methods were suggested for the study of radio-frequency spectra, for example, resonance methods in atomic and molecular beams, etc.

383. In 1951-1952, as a result of the analysis of the processes of interaction of the quanta of an electromagnetic field with matter, it was shown that there existed the principal possibility of employing quanta systems for the generation and amplification of electromagnetic waves (Physics Institute imeni P. N. Lebedev of the Academy of Sciences USSR, Columbia University, USA). The first quantum oscillators were developed in 1954-1955 — molecular oscillators with a beam of ammonia molecules (Physics Institute imeni P. N. Lebedev, Columbia University). In 1954, a beam of cesium atoms was used for the development of an atomic frequency standard (Harvard University in the USA, National Physics Laboratory in England). That same year, semiconductor parametric amplifiers were proposed (Physics Institute imeni P. N. Lebedev). In 1957-1958, quantum, so called paramagnetic, amplifiers were developed which use the spectral lines of electron paramagnetic resonance (Physics Institute imeni P. N. Lebedev, Harvard University, the "Bell System" company in the USA). Finally, in 1958-1959, parametric amplifiers were developed (Institute of Radio Engineering and Electronics of the Academy of Sciences USSR, "Bell System").

384. The enumerated works served as the basis for a new field, arising at the junction of radio engineering and physics, a field which makes considerable use of the methods of quantum mechanics and which has received, at the present time, the name of quantum radiophysics.

385. At the basis of operation of molecular oscillators and paramagnetic amplifiers lies the induced emission of excited quantum systems. The effect of induced emission was discovered by A. Einstein in 1917 in connection with the study of the equilibrium between a quantum system having discrete energy levels, and the radiation field.

386. Let us examine the quantum system with two energy levels (figure 1). During interaction with the external electromagnetic field, it can absorb and emit quanta of energy. Let the particle be initially located at the lower energy level. Under the influence of an external electromagnetic field, it may absorb the field quantum and move to the higher energy level. Such a process is related to a decrease in field energy and is called resonance absorption.

387. A particle found at the higher energy level may emit a quanta and move to the lower energy level under the influence of an external electromagnetic field. This process is related to an increase in field energy and is called induced emission.

388. The probability of both processes is identical and proportional to the density of the energy field. Thus, with an interaction of the particle with the external field, the particle will be continuously changing from one level to the other, emitting and absorbing quanta.

389. In addition to resonance absorption and induced emission, there is one other process — so-called spontaneous emission. Essentially, this is explained by the fact that the particle can not exist for an infinitely long time at the upper (excited) level and spontaneously moves to the lower level with an emission of quanta. This process continues in the absence of quanta in the external field. Spontaneous emission explains the glow of heated bodies, luminescence, etc.

390. As a result of the presence of the three processes — induced emission, resonance absorption and spontaneous emission — an equilibrium occurs between the molecules and the quanta of the field.

391. Let the gas of temperature T, having two insulated energy levels, be confined to a cavity with mirrored walls for roflection of emission, also having a temperature T. Under the influence of thermal motion, the molecules will strike each other and the walls of the vessel, which will result in a specific distribution of molecules according to energy levels which is described by the Boltzmann equation:

$$N_i \sim e - E^{i/KT}$$

in which N_i is the number of molecules at the i level, E_i is the energy of the level, k is the Boltzmann constant, T is the absolute temperature.

392. The heated walls which enclose the gas emit quanta, as a result of which a certain amount of quanta are in the vessel and their quantity is determined by the temperature of the walls. These quanta will interact with the molecular system resulting in induced emission and resonance absorption. However, if the temperature of the gas and the temperature of the vessel are the same, the number of absorbed quanta will be equal to the number of emitted quanta and a dynamic equilibrium takes place between the molecules and the emission.

393. Thus, in accordance with the Boltzmann formula, for each temperature value there is a corresponding specific distribution of molecules according to energy levels; furthermore, there will be less particles at the higher energy level than at the lower one. The difference in the number of molecules at adjacent levels depends upon the difference in energy of these levels and upon the temperature. For waves in the centimeter band, the difference in the number of molecules at the levels is very small and is only 1/1000 part of the number of particles existing at the level.

394. If external radiation is passed through the molecular system, then it will interact with the molecules, causing resonance absorption and induced emission; and, as a result of the fact that the higher energy level will have less particles than the lower one, resonance absorption will prevail over the induced emissions, i.e., the system, which is in thermodynamic equilibrium, will absorb the external emissions falling into it. Collisions between molecules will restore the distribution of molecules, disrupted by the emission, according to energy levels; in addition, the field energy will practically completely change to a thermal motion of the molecules and increase the temperature of the gas.

395. If the average time between changes of molecules from one level to the other under the influence of the external field is greater than the average time between the strikings of molecules (weak external field), then the thermal equilibrium in the molecular system is not strongly disturbed. Also, the number of quanta absorbed by the system will be proportional to the power of the field. And if the average time for the transfer of the molecules from one level to another is less than the average time between collisions of the molecules (strong external field), then a considerable disruption of the thermal equilibrium and a further increase in the field energy occurs, beginning from a certain limit, without an increase in energy absorption. This effect has received the name of saturation effect. At a strong saturation (that is, with a sufficiently high field amplitude) the number of molecules at the upper and lower levels becomes identical, while the number of absorbed quanta is determined by the number of molecule collisions and does not depend upon the external field.

396. Induced emissions practically play no role in the optical and infrared frequency bands, since the emission sources which exist in these bands give a comparatively low number of quanta and the interaction of molecular systems is always rather weak here. For the radio frequency band, in which very powerful monochromatic emission sources exist, the saturation effect is very easily achieved. We will show that an emission power of 1 microvolt at a wave length of 1 cm. corresponds to the radiation from a 1 cm^2 surface of a black body heated to a temperature of 10^{12} degrees.

397. So that the quantum system may strengthen the quanta falling upon it, it is necessary to disturb the thermal equilibrium, where upon at a higher energy level a greater number of molecules are found than at a lower energy level. In such systems, induced emissions will prevail over resonance absorption, and the emission intensity will begin to increase in passing through the system.

398. Formally, quanta systems having more molecules on the upper level than on the lower, may be described by a negative temperature. Actually, if in the Bol'tsman formula

$$N_i \sim e^{-E_i / kT}$$

we consider the value of T as negative, then the number of particles will be increased with an increase in energy, i.e., there will be more particles at the higher energy levels than at the lower.

399. The condition of a system with a negative temperature is unstable; it will be disturbed by both molecule collisions and by interaction with emissions.

400. In the event of an absence of interaction between the particles and the absence of quanta, the life time of a system with negative temperature is determined by the time of spontaneous emission of molecules which strongly depends upon the emission frequency. For the centimeter band, it is 10^{6} seconds, whereas for the optical band, the time is 10^{-8} + 10^{-10} seconds.

401. The long life of the excited particles in the centimeter wave band facilitates obtaining systems with negative temperatures in this band.

402. There has now been developed a number of methods for obtaining systems with negative temperatures in the centimeter wave band. Such systems may intensify the electromagnetic radiation which falls upon them at the expense of the quanta of induced emission. It is necessary to mention that the quanta, emitted by a negative temperature system, are, under induced emission, identical to the falling quanta in the sense of direction of propagation, polarization, and frequency.

403. If the quantum system is placed in a cavity with radiation-reflecting walls, then such a system, under certain conditions, may serve as a generator of electromagnetic radiation. Actually, if each arbitrarily formed quantum, before it is absorbed, is able to cause an induced radiation greater than one quantum in the system, then the amplitude of oscillations will grow. Such a system is a self-oscillating system — a generator. In spite of the fact that the levels between which the negative temperature is obtained has a

finite width, the electromagnetic oscillations in the molecular generator are highly monochromatic. This is a result of the fact that induced radiation may occur only at the frequency of external force. Therefore, in a molecular generator, the oscillations are excited at a frequency where the probability of quanta radiation had a maximum value — at a frequency close to the peak of the spectral line.

404. The schematic of a molecular generator using a beam of ammonium molecules is depicted in figure 2. The generator consists of three basic parts:

405. 1. A source of the molecular beam which has a rather small volume and is closed on one side with a small screen. Inside this space, a gas pressure of 1mm Hg is maintained. The molecules which pass through the small openings of the grid without colliding with it then fly out into the vacuum space of the generator in the form of a molecular beam.

406. 2. The sorting system is in the form of a cylindrical condensor, the field of which decreases upon approaching the axis of symmetry. If a molecular beam is passed through such a condensor then the molecules which are on the upper energy level begin to rush into the space where the field is a minimum, i.e., will be focused around the condensor axis. The molecules which are on the lower energy level will rush into the space where the field is maximum, i.e., they will be defocused. Therefore, the beam of molecules flying out from the condensor close to the axis, consists primarily of molecules found at the upper level, i.e., they possesses a negative temperature.

407. 3. The oscillatory circuit is tuned to the frequency of change of molecules between levels. Differing from the oscillatory circuits for low frequencies which consist of condensors and self-inductance coils, the oscillatory circuit for 1 cm wave lengths is a metallic cavity with excellent wave-reflecting walls. This so-called cavity resonator is widely used in the centimeter wave band.

408. The molecular beam, having a negative temperature, passes into the cavity resonator inducing oscillations in it at the frequency of the molecular transfer. Since the molecules in the molecular beam have practically no interaction between themselves, the spectral line used in the molecular generator has a very narrow width (1 kilocycle at an oscillation frequency of 24,000 megacycles). Therefore, such a generator possesses very high frequency stability.

409. Through the comparison of the frequency of molecular generators, it was determined that it changes in one second by not

more than several units of the thirteenth decimal sign. However, in a lengthy comparison of the generator frequencies, it was possible to show the dependence of the frequency on various factors: the value of the natural frequency of the oscillatory circuit, the intensity of the molecular beam, the voltage on the sorting system, etc. A theory was developed which permits an explanation of the frequency relationships noted.

410. On the basis of theory and experiments, the Physics Institute imeni P. N. Lebedev proposed a method of tuning generators in which the frequencies of two independent generators may be made equal to each other with an accuracy of up to one unit of a tenth decimal sign. This means that if the oscillations of the generator are used as a stable element ("pendulum") of a clock, then the error of such a clock will be not more than 1 second in 300 years of uninterrupted operation.

411. Work is being conducted towards further increasing the stability of the frequency of molecular generators. Methods have been developed in the Institute for increasing the stability of molecular generator frequencies through the use of beams in which the molecules have a low speed in comparison with thermal speeds at room temperature. Calculations indicate that through the use of such systems it is possible to increase by 10-100 times the frequency stability of molecular generators.

412. Together with the molecular generator, another device for measuring frequency and time which has received considerable development is based on quanta transfers of cesium atoms — a so-called cesium frequency standard. As distinguished from a molecular generator, it is not a source of radio oscillations. Through the use of an atomic beam, it is possible to obtain, in a cesium frequency standard, a very narrow spectral line which is used to measure the frequency of a stable quartz oscillator. The accuracy of a clock utilizing a cesium line has, at the present time, the same accuracy as clocks using a molecular generator.

413. Now, generators may be built which will retain their frequency over a short period of time with a considerably higher accuracy than that with which we know how to tune their frequency to the frequency of the spectral line.

415. The problem of developing amplifiers using quanta systems with negative temperatures is closely tied in with the problem of molecular generators. However, if in the case of the generators we strive to obtain the most stable possible frequency, i.e., use narrow spectal lines, the amplifiers must have the widest possible passband. Therefore, crystals with paramagnetic ions are used as

the working substance in molecular generators. By using such crystals in an external magnetic field, as was first demonstrated by Ye. K. Zovoyskiy, it is possible to observe spectral lines connected with the spin reorientation of paramagnetic ions. These lines have considerable width which permits the creation of a sufficiently wide-band amplifiers. The amplifier frequency may be easily tuned by varying the voltage of the external magnetic field.

416. A schematic diagram of the amplifier is shown in figure 4. The amplified wave passes through the medium with a negative temperature and, by virtue of the quanta of induced radiation, the wave power is increased by passing through the working matter of the amplifier (a ruby). Auxilliary radiation, the frequency of which must be greater than the frequency of the amplified signal, is used to obtain a negative temperature in paramagnetic crystals.

417. The action of the auxilliary radiation is explained in figure 5. In a thermodynamic equilibrium, the number of ions decreases with a growth in their energy; furthermore, the difference in the number of ions at two different energy levels increases with a decrease in the temperature of the sample. At a temperature $T = 0$, all ions will be found on the very lowest energy level.

418. If a sample having the level arrangement shown in figure 5 is acted upon by radiation whose frequency causes a change between levels 1 and 3, then at a high radiation intensity, sufficient to achieve a saturation effect between these levels (i.e., the number of ions on 1 and 3 become equal), then a negative temperature may develop between levels 3 and 2 or between 2 and 1.

419. Normally, the amount of amplification when passing through a 1 cm medium with negative temperatures is small and, therefore, to obtain amplification, up to 100 times for example, a system must be selected having a length on the order of several meters, which is for practical purposes, inconvenient. In order to decrease the dimensions, use is made of resonators or of so-called delay systems in which the group velocity of the amplified wave is decelerated 100 times, thereby permitting a corresponding decrease in the dimensions of the system.

420. Paramagnetic amplifiers may operate at liquid helium temperatures ($T = 4.2^{\circ}$ K).

421. The noises in molecular amplifiers operating at sufficiently low temperatures are explained by the spontaneous emissions of excited ions. The noise temperature of spontaneous emission is determined by the frequency of the amplified signal and, for waves in the centimeter band, it is several degrees Kelvin.

422. Centimeter band receivers have a noise temperature of several thousand degrees, i.e., the use of molecular amplifiers, in principle, permits a gain of 1000 times. In practice, however, this gain is considerably less, since we must take into account the presence antenna noises, atmospheric emissions, Galactic noises, etc.

423. Together with molecular amplifiers, there have recently been developed so-called parametric amplifiers in which the "negative losses" in the oscillatory circuit occur as a result of the modulations of the parameters of this circuit by an external force at a frequency which differs from the frequency of the amplified signal. As a modulating element, parametric amplifiers use either the capacitance of semiconductor diodes or inductance with special ferrite crystals. These amplifiers also permit a considerable gain in sensitivity in the decimeter and centimeter wave bands.

424. A step-by-step examination of the action of parametric amplifiers also requires the application of the laws of quantum mechanics. This refers, for example, to the examination of specific spontaneous emission of noises which are inherent in parametric amplifiers.

425. Thus, the development of quantum radiophysics permitted the solution of two extremely important problems in radio engineering: to substantially increase the frequency stability of generators and strongly increase the sensitivity of receivers in the centimeter and decimeter wave bands.

426. It is necessary to emphasize once more that the achievements of quantum radiophysics are closely related to achievements in radiospectroscopy, which has served as a dependable foundation for the evolution of this new branch of science.

427. At the present time, work is under way on the use of induced radiation of quanta systems with negative temperatures for the generation and amplification of submillimeter and infrared radio waves.

428. To obtain systems with negative temperatures, in this case one can also use molecule sorting by means of deflecting the molecular beams into nonhomogeneous constant electrical and magnetic fields or by acting on quanta systems with auxilliary radiation.

429. To obtain conditions with negative temperatures through the use of auxilliary radiation in the infrared range, monochromatic emission sources are required in a higher frequency band, providing

considerable power in a narrow frequency interval. Thus far, there are no sources like this. Although molecular sorting in beams is possible in a number of instances, as a result of the low concentration of molecules here one can expect comparatively low powers. Therefore, it is necessary to search for new methods of achieving negative temperatures in such quanta systems where, with a considerable concentration of particles, it will be possible to obtain comparatively narrow spectral lines. In this connection, great interest is exhibited in the study of the infrared spectra of various single crystals. In particular, in the past few years, a detailed study was made of the spectra of various semiconductor crystals.

430. In semiconductor crystals at low temperatures it is possible to obtain sufficiently intensive and comparatively narrow spectral lines, caused by electron transfers. Recently, methods were suggested by the Physics Institute imeni P. N. Lebedev for obtaining negative temperatures in semiconductor systems. Experimental research has now begun on the possibilities of obtaining negative temperatures in semiconductors.

431. On a level with the work on the development of amplifiers and generators in the infrared zone, research is being conducted in the submillimeter wave band.

432. In conclusion, we will pause briefly on those problems which may be presented and solved in connection with the development of quantum radiophysics.

433. The current development of receivers utilizing molecular amplifiers will permit, under winter conditions and with good antennas, a gain in sensitivity in comparison with ordinary receivers of up to 100 times. This gain will be even more significant if it will be possible to extend the antennas beyond the limits of the earth's atmosphere (for example, to locate them in an artificial Earth satellite). Such a significant increase in sensitivity opens vast possibilities for radar, radio nevigation, cosmic communication, and in a number of other fields of technology.

434. The use of molecular amplifiers in radioastronomy greatly increases the limits of the Universe available for observation through the use of radiotelescopes. Particularly interesting is the use of molecular amplifiers for observing emission lines of metagalactic hydrogen, lying in a range of 21 cm, with the aim of studying the red displacement of this spectral line.

435. The increase in the sensitivity of radio telescopes has permitted the development of activities on the detection of the

emissions of various chemical compounds and radicals which may be found in minute quantities in cosmic space.

436. The high accuracy of the molecular and atomic clocks permits a significant increase in the accuracy of radar and radio navigational instruments, including those which will be used in inter-planetary navigation. New courses of study of the ionosphere are being opened.

437. Due to the high accuracy of molecular and atomic frequency standards, possibilities have arisen for a completely new approach to the problem of studying the motion of heavenly bodies, since astronomers have now obtained clocks whose movement is not connected with this motion. As a result, it has now become possible to detect and begin the study of the irregularity in the Earth's rotation. Work has begun on the comparison of the "astronomical" clocks with the "atomic" and "molecular" ones.

438. The high relative frequency stability of molecular generators permits the initiation of an experimental verification of the conclusions of the general theory of relativity on the relationship of the speed of a clock to the gravitational potential. If, for the verification of the theory of relativity, an artificial Earth satellite is used in which a molecular generator has been placed, then it will be possible to obtain a frequency change of several cycles in comparison with the generator on the Earth. Such a frequency change may be fully observed with the aid of currently available generators. However, a practical application of this experiment meets with serious difficulties which, first of all, are concerned with the great changes in frequency as a result of the considerable speed of the satellite (the Doppler effect of the first order). Frequency displacement is explained by the satellite's speed which is tens and hundreds of thousands times greater than the gravitational changes in the frequency. A number of ideas have been suggested for compensating for the Doppler effect with high accuracy, and, at the present time, all of the prerequisities are available for the initiation of work on the experimental verification of the general theory of relativity under "earth conditions".

439. The possibilities opened by quantum radiophysics have attracted the attention of a great number of scientists and engineers. Many institutes are conducting work on the development and introduction of quantum devices. All of this lets us hope that in the near future, quantum radiophysics will assist in the solution of many problems which, at the present time, are confronting science and technology.

FIGURE APPENDIX

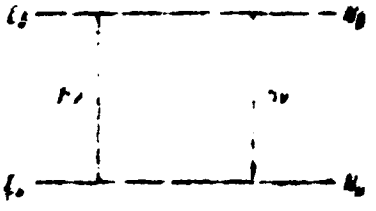

Figure 1. Two-level quantum system.

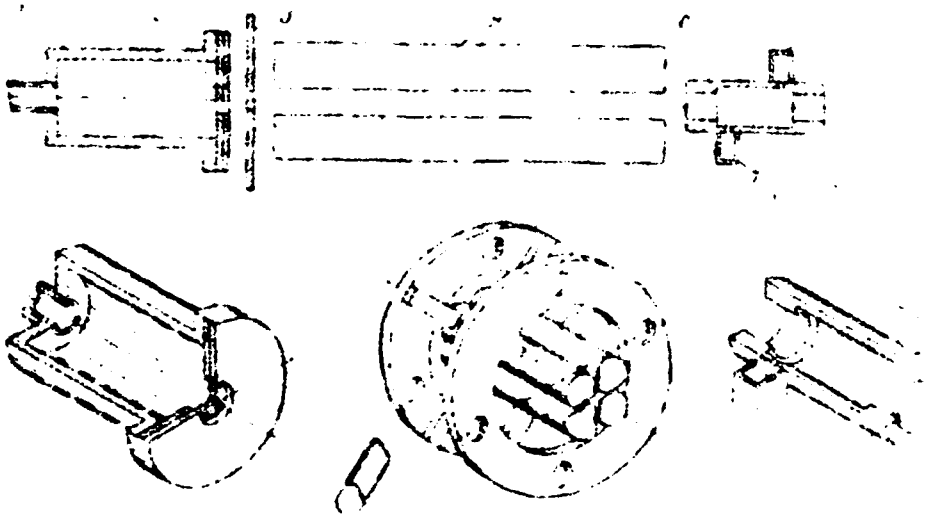

Figure 2. Structural diagram of a molecular generator.
1 - beam source, 2 - screen, 3 - diaphragm, cooled by liquid nitrogen, 4 - electrodes of the quadripole condensor, 5 - quadripole condensor, 6 - resonator, 7 - wave guide.

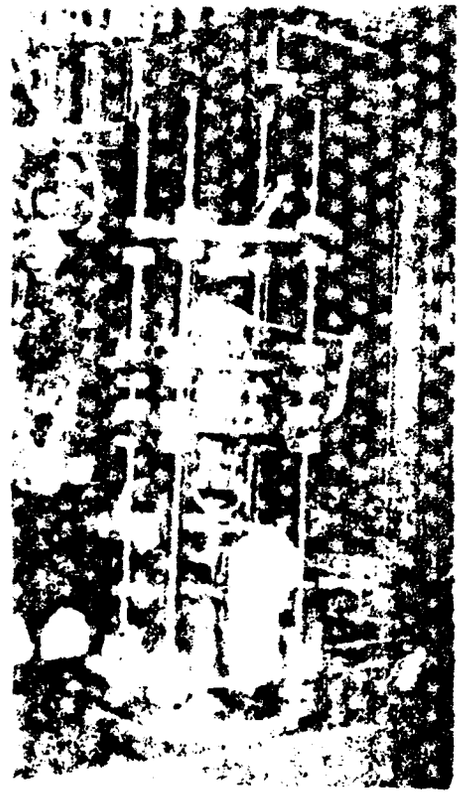

Figure 3. Overall view of a molecular generator.

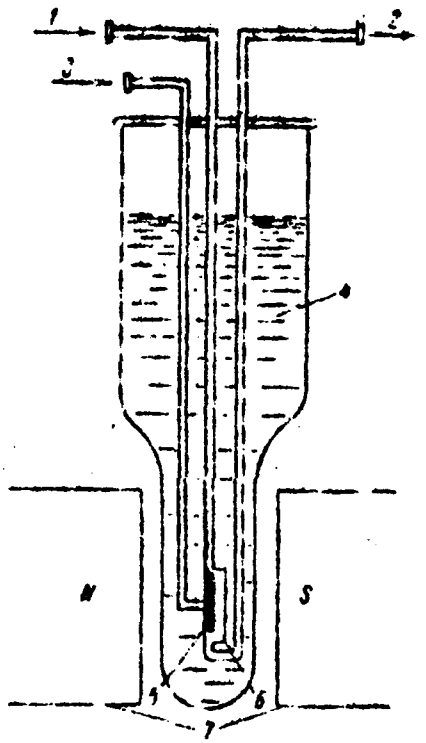

Figure 4. Structural diagram of a paramagnetic amplifier. 1 - amplifier input, 2 - amplifier output, 3 - auxilliary radiation, 4 - helium, 5 - paramagnetic substance, 6 - delay system, 7 - magnetic poles.

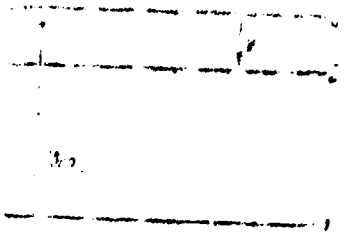

Figure 5. Three-level quantum system.

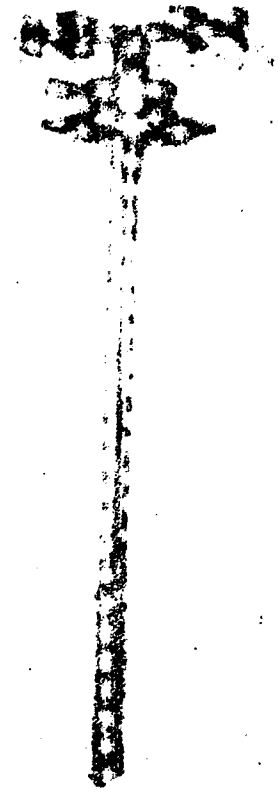

Figure 6. Paramagnetic amplifier beam, magnet and cryostat.

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